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A Comparison of Warsaw Pact and NATO Defense Activities, 1976-86

A Research Paper

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SOV 87-10077
EUR 87-10032
December 1987

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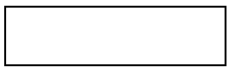

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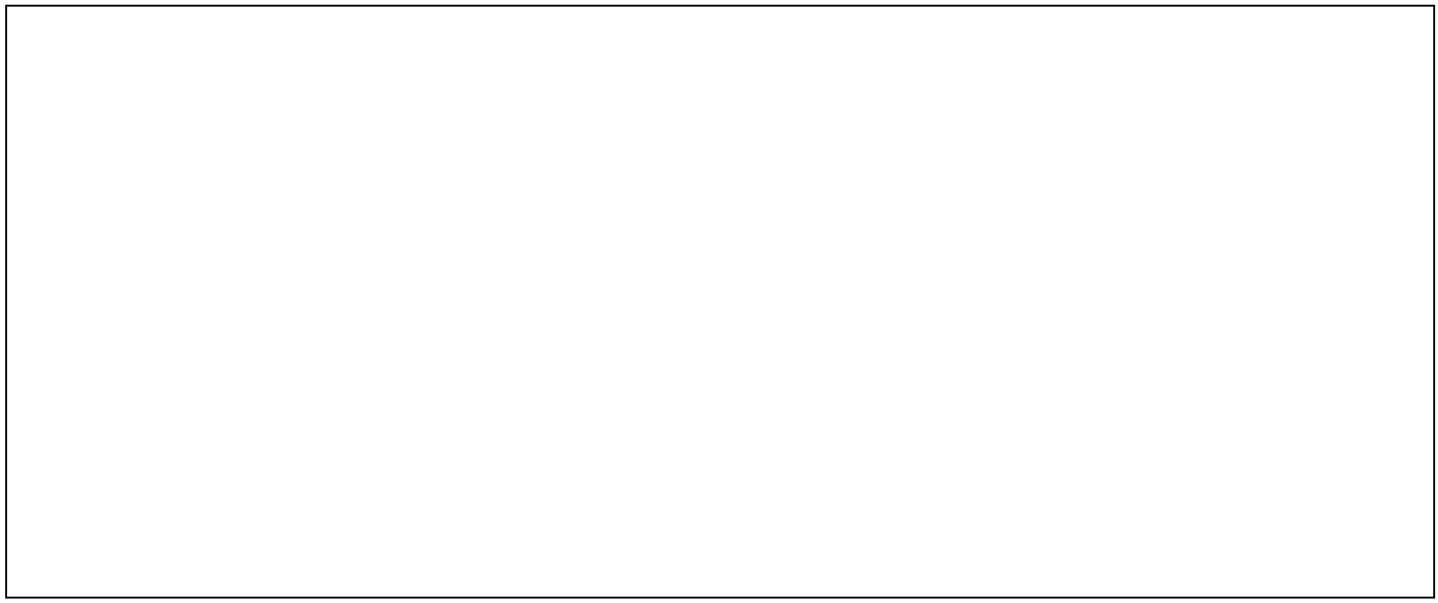

A Comparison of Warsaw Pact and NATO Defense Activities, 1976-86

A Research Paper

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Comments and queries are welcome

A Comparison of Warsaw Pact and NATO Defense Activities, 1976-86

Scope Note

This research paper is our first published comparison of the overall defense activities of NATO and the Warsaw Pact. It builds upon our previous published comparisons of US and Soviet defense activities [1] and upon an assessment of the defense activities of the non-Soviet Warsaw Pact countries published in 1986.[2] Like these earlier intelligence studies, in addition to using physical measures such as the numbers of weapons procured, this paper uses a monetary valuation—specifically, estimated dollar costs—to aggregate and compare diverse defense activities and programs. For the readers' convenience, dollar values of defense programs presented in this paper are shown in graphics and tables as point estimates rather than as ranges. The reader should remember, however, that around each estimate is an implicit confidence band and that, in general, our certainty is greater for higher levels of aggregation.

[1] For our most recent publication, see DI Intelligence Assessment SOV 86-10028 (Secret NF), May 1986, *A Comparison of Soviet and US Defense Activities, 1976-85.*

[2] See DI Intelligence Assessment SOV 86-10018CX (Top Secret Codeword NF)

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A Comparison of Warsaw Pact and NATO Defense Activities, 1976-86

Summary

Information available as of 21 August 1987 was used in this report.

During 1976-86, both the Warsaw Pact and NATO improved their military forces considerably. Their force development programs, however, have involved different approaches reflecting fundamental differences in doctrine, strategy, and the nature of the two alliances. In comparing their numerous and diverse defense activities, we use in this paper both physical and value measures to provide aggregate indicators and to identify trends in force developments. Physical measures, such as manpower and the number of weapons procured, are used to provide rough indicators of comparative force size and weapons acquisition trends. The value measure—estimated US dollar cost—is used to aggregate activities and programs such as military aircraft and infantry regiments that have no other common denominator and to supplement rough quantitative comparisons of defense procurement with an indicator that takes account of differences in weapons quality.

The Pact's procurement policy has put more emphasis on quantity, and less on quality, than NATO's.

The Pact—with the Soviet Union playing the dominant role—acquired greater quantities of weapons than NATO in almost every major category: 50 percent more tactical combat aircraft, almost twice as many helicopters, 60 percent more submarines, twice as many tanks, twice as many armored personnel carriers, and almost six times as many artillery weapons. As the period progressed, the Soviets increased their emphasis on the production and deployment of more technologically advanced weapon systems in an effort to narrow NATO's technological lead. Still, by 1986, advanced systems represented only a small share of Soviet inventories for most categories of weapons, with the notable exception of land arms, where modern systems accounted for large shares of weapons fielded.

NATO, while not seeking to match the Pact in the number of weapons procured, focused on the acquisition of more advanced and individually more costly weapons to counter the Pact's numerical superiority. Surface ships are a notable exception. Here NATO enjoys a quantitative advantage over the Pact, mainly because of US requirements to transport reinforcements across the Atlantic and to maintain a global force structure.

The two alliances have also followed different approaches to operating and maintaining their military forces.

Pact operating procedures are designed to preserve equipment and maintain a high level of equipment readiness. Pact countries do not use their equipment as much as the NATO countries do. NATO uses its equipment more for training, in keeping with its emphasis on personnel and unit readiness, with consequent heavier demand on its peacetime logistics and maintenance system.

Warsaw Pact weapon inventories are more standardized than those of NATO.

The vast majority of Pact weapons are Soviet designed and Soviet produced, whereas, in NATO, several countries design and produce weapons for the same combat role. NATO, therefore, must maintain a more complex network of operations and maintenance infrastructures requiring more intensive training and more spare parts.

On the whole, the dollar value of NATO defense activities was greater than that of comparable Warsaw Pact activities.

The dollar value of NATO's defense activities exceeded those of the Pact by 5 percent in 1976 and by more than 25 percent by 1986, with the change resulting primarily from sharply increasing US defense outlays after 1980.

Although the Pact acquired greater quantities of weapons, the cumulative dollar value of military procurement in the two alliances was roughly the same during 1976-86.

The value of Pact procurement was much higher than NATO's at the start of the period, but by 1986 the dollar value of NATO procurement exceeded the Pact's by almost 40 percent. US procurement outlays—the key driver of this growth—almost tripled during 1976-86 as the United States embarked on a major military modernization effort.

In general, NATO's weapons were more costly on a per unit basis. Moreover, NATO, especially the United States, invested more heavily than the Pact in procurement categories other than weapons, including stocks of munitions, spare parts, and sophisticated training equipment.

Soviet, and as a result Pact, military procurement was at such a high level that the Soviets were able to procure large quantities of weapons even though the annual dollar value of procurement remained roughly constant.

The dollar value of Pact military procurement, which had grown on average almost 4 percent per year from the mid-1960s to the mid-1970s, experienced no growth during 1977-86.[3] In the non-Soviet Warsaw Pact (NSWP) countries, procurement growth was slow, and, as a result, the NSWP armed forces stayed well below the quantitative and qualitative standards of frontline Soviet units.

The dollar value of NATO's operations and maintenance (O&M) activities exceeded those of the Pact by 75 percent throughout 1976-86.

This is mainly a result of NATO's higher operating rates, its need to maintain technologically more advanced weapons, and its less standardized equipment holdings.

The non-US NATO countries play a much larger role in NATO defense activities than the NSWP nations do in the Warsaw Pact.

During 1976-86, the East European share of Pact defense activities measured in dollars remained level at about 15 percent of the total. In contrast, the dollar value of non-US NATO defense activities made up on average 40 percent of NATO's total. The non-US NATO countries contribute about 60 percent of total NATO military manpower; the NSWP nations contribute more than one-fifth of the Pact's.

On the basis of available evidence on the pace of weapons production and development programs, we expect the recent trends in Warsaw Pact military modernization to continue through the remainder of the 1980s, barring any major changes in East-West relations or in domestic political and economic conditions in the member countries.

[3] In this and other calculations of growth rates, the base year is the year prior to the stated period.

Although the requirements of Gorbachev's civilian industrial modernization program are tightening the competition for resources, we believe that defense procurement in the USSR in 1987-90 is likely to be slightly higher than in the past five years. If General Secretary Gorbachev's campaign to modernize the economy should falter, the Soviets might slow or cancel military programs in favor of nonmilitary production. Even at slightly lower levels of procurement, however, improvements in both Soviet strategic and conventional forces would be substantial.

The Soviets have been exerting increasing pressure on the NSWP countries to expand and improve their forces. Because of the current adverse economic situation in Eastern Europe and the resulting unwillingness of the NSWP countries to allocate more resources to the military, the development of the NSWP forces is likely to fall well short of Soviet wishes. The East European countries will have to replace older systems at a slower pace than in the past, cut other defense activities in favor of procurement, or buy older systems.

Within NATO, the prospects are mixed.

Although the non-US NATO countries as a whole carried out a significant modernization of their armed forces, reductions in defense procurement programs due to budgetary constraints have forced most of them to continue using older equipment. Delays and cuts by some allies—particularly Belgium, Denmark, Norway, and Canada—will make it increasingly difficult to meet all of their NATO commitments. These shortfalls, especially on the Alliance's northern and southern flanks, could force other allies to compensate by increasing defense activities or to accept a weakening in NATO's military posture. Current US plans call for modernization of weapons and equipment to continue in all three services.

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A Comparison of Warsaw Pact and NATO Defense Activities, 1976-86

Introduction

This assessment compares Warsaw Pact and NATO defense activities over the period 1976-86, using both physical and value measures. The physical measures used include data on the numbers of weapons acquired and delivered to military units, inventories of major weapon systems, and levels of military manpower. Such measures are useful in portraying the weapon mixes and the relative sizes of the two alliances. They cannot, however, be used to produce summary measures of diverse kinds of defense programs and military units such as tanks, tactical aircraft, and infantry regiments.

To aggregate such diverse programs and activities, some value must be assigned that captures the relative worth of each—in terms of physical and operational characteristics, resource costs, or some other quality. Because prices are a useful way to combine incommensurable quantities and because trends in defense activities are often related to overall developments in an economy, it has become common practice to develop aggregate measures based on the costs of the resources devoted to various defense activities. These costs can be calculated in any currency, but dollars are the frame of reference of US policymakers and force planners who are familiar with what a "defense dollar" can buy.

Dollar valuations, moreover, reflect differences in the technical and performance characteristics of military hardware as well as in the numbers of weapons procured. They can, therefore, be useful not only in portraying the relative magnitudes of similar programs and general trends in defense activities, but also in doing so in terms that take account of qualitative differences.

Dollar valuations, however, have the following limitations:

- *They do not measure actual Warsaw Pact and non-US NATO defense spending, the impact of defense on the respective economies, or the various countries' perceptions of defense activities.* The Soviets, East Europeans, and non-US NATO nations do not spend dollars. Issues of defense burden are properly analyzed with estimates of defense expenditures in domestic currencies. Dollar valuations of a foreign country's defense activities measure the cost at prevailing US prices, wages, and efficiencies to develop, deploy, and maintain a military force of the same size and with the same weapons as the foreign country and to operate those forces as that country does (see appendixes A and B). We do not address the question of whether the Warsaw Pact and non-US NATO nations would choose to have the same military establishments if they had to pay dollar prices instead of paying for their weapons and manpower in their own currencies. Presumably, if these nations had to make their decisions faced with a dollar price list, they would buy a different mixture of weapons and manpower.

- *Dollar values are not a measure of the overall military capabilities of NATO and Warsaw Pact forces.* Assessments of capability must take into account the accumulated stocks of military equipment and supplies; military doctrine and battle scenarios; the tactical proficiency, readiness, and morale of forces; the effectiveness of weapons; logistic factors; and a host of other considerations.

Methods

In the past we were able to compare the dollar value of Warsaw Pact and NATO defense activities only for the largest members of the two alliances: the Soviet Union and the United States. Recently, however, we

completed an estimate of the dollar value of non-Soviet Warsaw Pact (NSWP) and non-US NATO defense activities using a methodology consistent with that used for the US-Soviet comparison. This allows us, for the first time, to present a comparison of the entire Warsaw Pact and NATO alliances. (

The estimates of Warsaw Pact costs presented in this paper were derived using a building-block methodology (see appendix A). The dollar values of all Soviet and NSWP defense activities were developed by identifying all the Soviet and NSWP forces to be compared with NATO's, including their supporting elements, and then estimating order of battle, equipment inventories, and new equipment purchases. To these detailed quantities, we applied appropriate 1985 dollar prices. Because the building-block approach is based on the individual components of the Warsaw Pact defense effort, we can estimate defense program values by resource categories—investment; operating; and research, development, testing, and evaluation (RDT&E).

US data in this paper are expressed in terms of calendar-year outlays derived from the *Five-Year Defense Plan* (FYDP) issued by the Department of Defense in January 1986 and from the *Budget of the United States Government, Fiscal Year 1987*. Defense-related activities of the Department of Energy, the Coast Guard, and the Selective Service have also been included to improve the comparison with Warsaw Pact programs. The outlays are expressed in constant dollars so that trends reflect only real changes in military forces and activities and not the effects of inflation. US order-of-battle data were also derived from the FYDP; US production data were provided by the Department of Defense. (

The dollar value of defense programs for the non-US NATO countries was derived by adopting a method—the use of purchasing-power parities—in common use for international comparisons of civilian economic activities. Previously, NATO reported spending was converted to dollars using official exchange rates. Exchange rates, however, reflect one country's demand for another country's currency, not the amounts of each country's currency required to purchase equivalent goods and services. Purchasing-power parities, in contrast, which are constructed to represent ratios of prices for the same good or service expressed in two different currencies, are better conversion factors for Warsaw Pact–NATO sizing comparisons than exchange rates because they are more representative of the value of the goods and services being compared. This approach was also chosen because it is methodologically most consistent with the approach we use to estimate defense costs of the Warsaw Pact (see appendix B). (

Force Trends and Comparisons

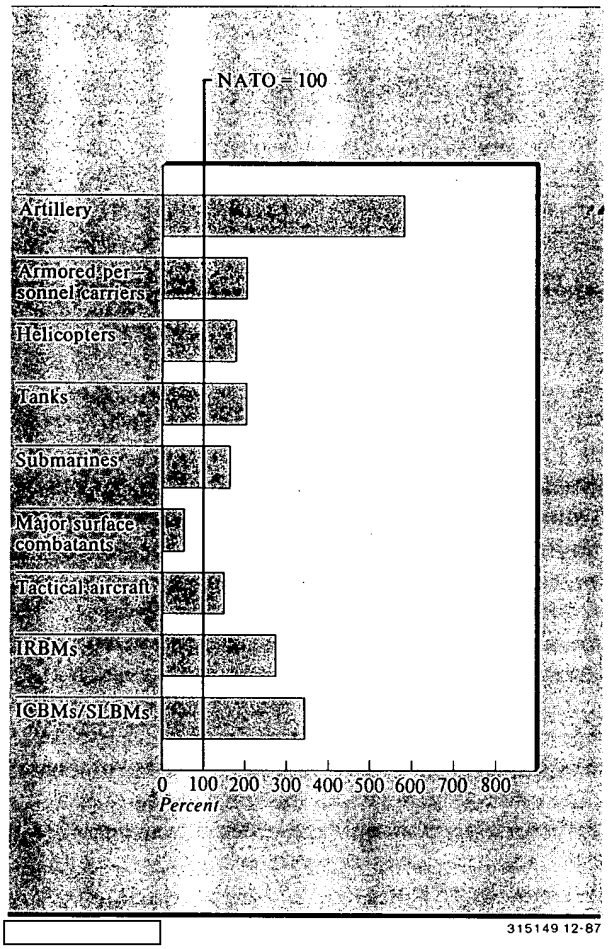
Weapons Acquisition

During the 1976-86 period, the Warsaw Pact acquired greater quantities of weapons than NATO in every category except ships. Compared with NATO, the Soviets and their allies acquired 50 percent more tactical aircraft, almost twice as many helicopters, 60 percent more submarines, twice as many tanks, twice as many armored personnel carriers, and almost six times as many artillery weapons, but only about half as many major naval surface combatants (see figure 1).[4] On the other hand, the comparisons in appendix C show that NATO systems are generally more complex, more capable, and therefore more costly than Pact systems. As a result, the dollar value of Warsaw Pact procurement during 1976-86 was only 3 percent higher than the dollar value of NATO procurement. (These value comparisons are discussed in the section "Dollar Value of Defense Activities.") (

Differences in Weapons Acquisition Policies. The large acquisition of weapons by the Warsaw Pact during 1976-86 reflects its strong commitment to modernizing its armed forces and maintaining the quantitative advantage it historically has enjoyed over NATO in the area of conventional weaponry. Indeed, in 1986 the Pact had substantially more arms than

[4] The NATO data include France, which is a member of NATO but does not participate in NATO's integrated military command. The data exclude Spain, which did not decide on its formal accession to the Alliance until 1986, and hence was not an integrated member during the 1976-86 period. (

Figure 1
Warsaw Pact Acquisition of Major Equipment Relative to NATO Acquisition, 1976-86



NATO in most major categories, particularly in land arms. In general, Pact strategy focuses on preparing for conflict in continental Europe. Although the USSR, the dominant member of the Warsaw Pact, maintains a large blue-water navy and some forces outside Europe, the Soviets do not have a global posture in the same sense as the United States. As a result, while the Pact maintains a large inventory of land arms and aircraft, its naval forces, while growing, are smaller than NATO's (see table 1).

Although Soviet—and hence Warsaw Pact—force development traditionally has featured the acquisition of large quantities of less advanced weapon systems, the Soviets have been concerned for years with the threat NATO's more advanced weapons would pose to their forces in a war in Europe. As a result, they have begun introducing more advanced systems such as the T-80 tank and MIG-29, MIG-31, and SU-27 tactical combat aircraft. These new systems, however, still represent only a small share of the weapons fielded by Soviet forces. In 1986, for example, new systems represented only about 4 to 5 percent of the Soviet inventory of tactical combat aircraft. Land arms are an exception; in 1986, 20 percent of the Soviet inventory of tanks and armored personnel carriers were modern.

The East Europeans, whom the Soviets have asked to take an increasing role in Pact strategy, have made notable progress in modernizing some parts of their forces. They have introduced MIG-23 Flogger aircraft as replacements for aging MIG-21 Fishbeds, deployed SA-5 missiles, acquired large numbers of BMP armored personnel carriers, and introduced relatively modern self-propelled artillery such as the Czechoslovak-produced 152-mm howitzer and the Soviet-produced 2S1 122-mm and 2S3 152-mm howitzers. Nevertheless, much of the NSWP inventory still consists of weapon systems introduced before 1970. The East European countries still lag behind the USSR in fielding self-propelled artillery, modern armor, mobile SAMs, attack helicopters, and modern aircraft. In the mid-1970s the ground forces in the northern-tier countries—East Germany, Poland, and Czechoslovakia—trailed Soviet forces stationed in Eastern Europe by five to 10 years or more in many weapons categories. The southern-tier nations—Hungary, Romania, and Bulgaria—had even fewer modern weapons. Since the mid-1970s the gap in quality between Soviet and NSWP forces has widened. Probably most disturbing to the Soviets is the fact that the NSWP forces are falling behind in precisely those categories of equipment most critical to the Soviet conventional strategy, which is based on integrated firepower and the combined-arms maneuver.

Table 1
Warsaw Pact and NATO Inventories of Selected Weapons, 1986

Weapon Category	USSR	NSWP	Warsaw Pact	US	Non-US NATO	NATO
Tactical aircraft	9,400	4,100	13,500	6,050	4,700	10,750
Major surface combatants [a]	280	9	289	230	227	457
Submarines [b]	320	5	325	139	122	261
Tanks	52,500	12,700	65,200	12,000	16,900	28,900
Helicopters	7,250	750	8,000	10,500	4,100	14,600
APCs/IFVs	54,600	17,300	71,900	19,500	35,300	54,800
Artillery [c]	34,600	6,600	41,200	5,500	8,700	14,220

[a] Includes major surface ships of 1,000 tons or more.
[b] Includes SSBNs.
[c] Excludes mortars and multiple rocket launchers.

NATO, on the other hand, has emphasized nuclear weapons for deterrence rather than building large conventional war-fighting capabilities. In large part as a result of this emphasis, NATO has smaller conventional forces than the Pact and has focused on the acquisition of smaller numbers of more advanced weapons to counter the Pact's numerical superiority.

In general, the Warsaw Pact has placed less emphasis than NATO on pushing the state of the art in designing its weapons. Many Warsaw Pact weapon systems were developed through an evolutionary design process, drawing on older Soviet weapon designs. These include the T-80 tank, the TU-160 Blackjack bomber, and the AN-124 Condor transport aircraft. NATO weapons, in contrast, are generally designed from scratch, and, as a result, are more technologically advanced and more costly.

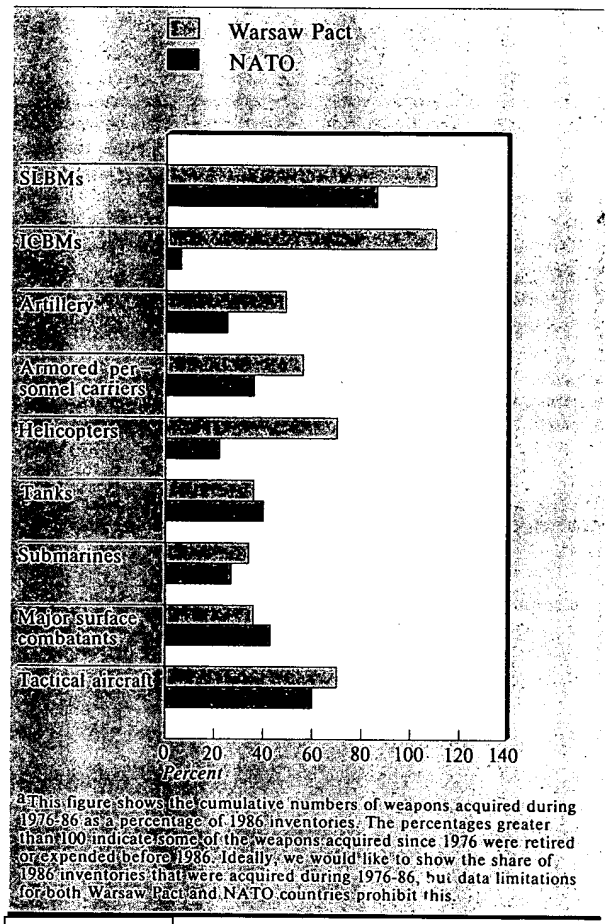
It is not, however, invariably the case that Warsaw Pact weapons have a lower dollar cost and higher production runs than NATO's. As shown in appendix C, some Soviet weapon systems are more costly than comparable NATO weapons. NATO, which emphasizes forces needed to transport and protect reinforcements transiting the Atlantic, also acquired more of the weapons associated with this mission than did the Warsaw Pact.

Because the Warsaw Pact acquired more weapons than NATO in almost every category during 1976-86, newly acquired weapons account for a larger share of current inventories in the Pact than in NATO (see figure 2). Many of the systems acquired were older designs. Still, a larger share of newly acquired systems in its inventory is an advantage that the Pact enjoys over NATO. On the other hand, while NATO has carried out an extensive modernization of older weapons through retrofitting, the Warsaw Pact has only recently begun wide-scale retrofitting of its existing systems except land arms; retrofitting of land arms has been going on for several years in the Warsaw Pact.[5]

Differences in National Acquisition Programs. Within the Warsaw Pact, Soviet acquisitions accounted for the vast majority of weapons procured during the 1976-86 period. In NATO, on the other hand, the non-US countries, which collectively account for a

[5] We have insufficient data to derive the number of systems that have been retrofitted in both alliances. We are conducting research in this area to look at the broad levels and the impact of such activities on the armed forces of NATO and the Warsaw Pact.

Figure 2
Weapons Acquired During 1976-86 as a Percentage of 1986 Inventories[a]



[a] This figure shows the cumulative numbers of weapons acquired during 1976-86 as a percentage of 1986 inventories. The percentages greater than 100 indicate some of the weapons acquired since 1976 were retired or expended before 1986. Ideally, we would like to show the share of 1986 inventories that were acquired during 1976-86, but data limitations for both Warsaw Pact and NATO countries prohibit this.

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major share of deployed forces, also acquired a large share of the weapons procured in the period (see table 2 and figure 3). The larger contribution to weapons acquisition by the non-US NATO countries relative to the NSWP partly reflects the non-US NATO countries' more active role in the alliance and their larger and more technologically advanced production base. (

The NSWP countries, with the exception of Romania, import almost all of their major weapon systems—aircraft, missiles, submarines, and surface ships—from the USSR. Their imports enable the Soviets to lengthen production runs and thereby reduce unit production costs through economies of scale. The East Europeans are more self-reliant in the production of land arms, although they depend on Soviet designs and production processes. During the 1970s, in an effort to give impetus to NSWP modernization programs and to reduce the growing disparity between Soviet and NSWP force capabilities, the Soviets pushed for greater integration of East European defense industries in producing general purpose weapons. This effort had the following consequences:

- NSWP defense industries, while continuing to supply the Soviets with armored personnel carriers, infantry fighting vehicles, and artillery, increased their concentration on simpler air and naval support systems such as transport aircraft and amphibious warfare ships as well as small arms, munitions, and weapon components. This eased the design and production demands on NSWP industry and lessened the opportunity for leakage of sensitive Soviet technology. NSWP concentration on support systems also reduced Soviet dependence on militarily vulnerable NSWP plants for critical weapons and enabled Pact rear services to draw on local sources for parts.

- Specialization in components probably resulted in greater economies of scale but may have done so at the expense of rendering programs more vulnerable to disruption because production problems in any one country can slow or halt production in others.

Militarily, standardization in Soviet armaments probably has increased NSWP capabilities; economically, Pact countries have benefited from the experiences associated with specialization. As a result, both the Soviets and the NSWP countries probably have been generally pleased by the standardization and specialization programs.[6] NSWP specialization in less

[6] See DI Research Paper SOV 86-10037CX (Top Secret C
August 1986, *Management of Warsaw Pact Weapons Acquisition: Soviet Goals and Pact Reality.*

Table 2
Warsaw Pact and NATO Acquisition of Selected Major Weapon Systems, 1976-86

	Warsaw Pact	NATO
Strategic nuclear forces	USSR: Over 1,000 SS-17, SS-18, and SS-19 fourth-generation ICBMs and 72 SS-25 ICBM launchers. Four Typhoon and three Delta-IV SSBNs. Over 1,000 SLBMs, mostly SS-N-18s, SS-N-20s, and SS-N-23s carrying MIRVs. Introduction of the Bear H and Blackjack strategic bombers with a cruise missile capability. About 700 SS-20 IRBMs and over 300 Backfire bombers for peripheral attack.	US: About 150 ICBMs including 12 Peacekeepers. Retrofitted 350 Minuteman III ICBMs. Almost 600 SLBMs, including the D-5 missile. Eight Ohio-class SSBNs, 28 B-1B bombers, 216 Pershing-2 IRBMs.
	NSWP: None.	Non-US NATO: France acquired about 40 new S-3 IRBMs, 85 new M-4 and M-20 SLBMs, and three new SSBNs.
Tactical combat aircraft	USSR: About 6,600 tactical aircraft, including almost 2,400 MIG-23 and MIG-27 Floggers, 1,500 SU-17 Fitters, as well as 700 modern aircraft such as the SU-27 Flanker, the MIG-31 Foxhound, and the MIG-29 Fulcrum.	US: Over 3,800 tactical combat aircraft including 780 F-15s, 1,075 F-16s, and 706 A-10s for the Air Force, and 359 F-14s, 332 F-18s, and 191 A-7s for the Navy.
	NSWP: Over 550 MIG-21 Fishbeds, over 300 MIG-23 Floggers, only five MIG-25 Foxbats, and 22 SU-25 Frogfoot aircraft.	Non-US NATO: Over 2,600 tactical combat aircraft including almost 400 F-16s, 520 Tornados, over 200 Mirage F-1s and 2000s, and 400 Alpha Jet and 170 Hawk combat-capable trainers.
Major surface combatants [a]	USSR: 98 surface combatants including three Kiev-class carriers, 13 cruisers, 14 destroyers, and 71 frigates—most equipped with guided missiles.	US: 94 major surface combatants including four Nimitz-class aircraft carriers, eight guided-missile cruisers, 34 destroyers, and 47 guided-missile frigates.
	NSWP: Six frigates.	Non-US NATO: 101 major surface combatants including four light aircraft carriers, 20 destroyers, and over 70 frigates and corvettes.
General purpose submarines	USSR: 47 nuclear-powered submarines (eight with cruise missiles) and 31 diesel-powered submarines armed with torpedos.	US: 35 Los Angeles–class nuclear-powered attack submarines.
	NSWP: Four diesel-powered submarines.	Non-US NATO: 10 nuclear-powered attack submarines and some 17 diesel-powered submarines.
Tanks	USSR: Over 20,000 tanks, primarily T-64s and T-72s as well as 2,000 T-80s. Modernization of T-62s and T-55s.	US: Over 7,500 tanks including 3,600 M-1 Abrams models; modernization of existing M-48 and M-60 models.
	NSWP: Almost 3,300 tanks, about two-thirds of which were T-54/55s. The rest were mainly T-62s and a few T-72s.	Non-US NATO: 4,100 tanks including over 2,000 of the new West German Leopard II as well as over 1,000 of the modernized Leopard I's.
Helicopters	USSR: Over 5,100 helicopters, mostly MI-8 Hips, MI-2 Hoplites, and MI-24 Hinds; MI-26 heavy-lift helicopters introduced in the early 1980s.	US: Over 900 UH-60 Black Hawks, over 100 modernized Chinook CH-47Ds, over 380 AH-1 attack helicopters, some 170 AH-64 attack helicopters.
	NSWP: About 500 helicopters, mostly MI-8 Hips, MI-4 Hounds, and MI-2 Hoplites.	Non-US NATO: Over 1,600 helicopters, mainly British Lynx, Franco-British Gazelle, and West German BO-105 models.
Armored personnel carriers/infantry fighting vehicles	USSR: Almost 33,000 armored vehicles, of which about half were BMP-1 infantry vehicles and about 10,000 were modern models such as the BTR-70, BTR-80, and BMP-2. Modernizing BMP-1s with new antitank guided missiles.	US: 9,900 armored vehicles including over 2,600 infantry and cavalry versions of the Bradley infantry fighting vehicles.

Table 2 (continued)

	Warsaw Pact	NATO
	NSWP: Over 7,000 APCs including over 2,300 BMP-1s, more modern models including 100 BMP-2s and over 500 BTR-70s.	Non-US NATO: 1,100 Dutch YPR-765s, 900 new West German Fuchs wheeled APCs, almost 2,500 new French VAB wheeled APCs, and over 1,000 British Scorpion-family APCs.
Artillery	USSR: Over 15,000 artillery pieces, primarily 152- and 122-mm self-propelled guns.	US: Over 2,700 artillery pieces, over half of which were self-propelled.
	NSWP: Mainly old artillery weapons except for a few DANA 152-mm self-propelled howitzers, 2S1 122-mm self-propelled, and 2S3 152-mm towed howitzers.	Non-US NATO: 1,700 artillery weapons, including 500 Italian-German-British FH-70 towed howitzers and several hundred US M-109 self-propelled howitzers.

[a] Major surface combatants include all combat-capable ships over 1,000 tons displacement.

sophisticated weapons, subsystem and component production, and reliance on Soviet designs will probably intensify in the 1980s.

Although the United States is the single largest producer of weapons in the Alliance, total non-US NATO production levels are roughly comparable to those of the United States for most major categories of weapon systems. The non-US NATO countries are capable of developing and producing a wide spectrum of modern weapons. The major non-US NATO countries now produce their own ships, submarines, and combat aircraft. Most land arms procured by the non-US NATO countries are also produced in Western Europe. (

Readiness Strategy. In addition to following different approaches to military modernization, the two alliances have different policies for preparing their forces for war. The Warsaw Pact believes that the better its equipment is preserved the more ready it is for war. As a result, Pact forces have lower operating levels than NATO forces; they do not fly or drive as much or conduct nearly as many live fire exercises as do their NATO counterparts.

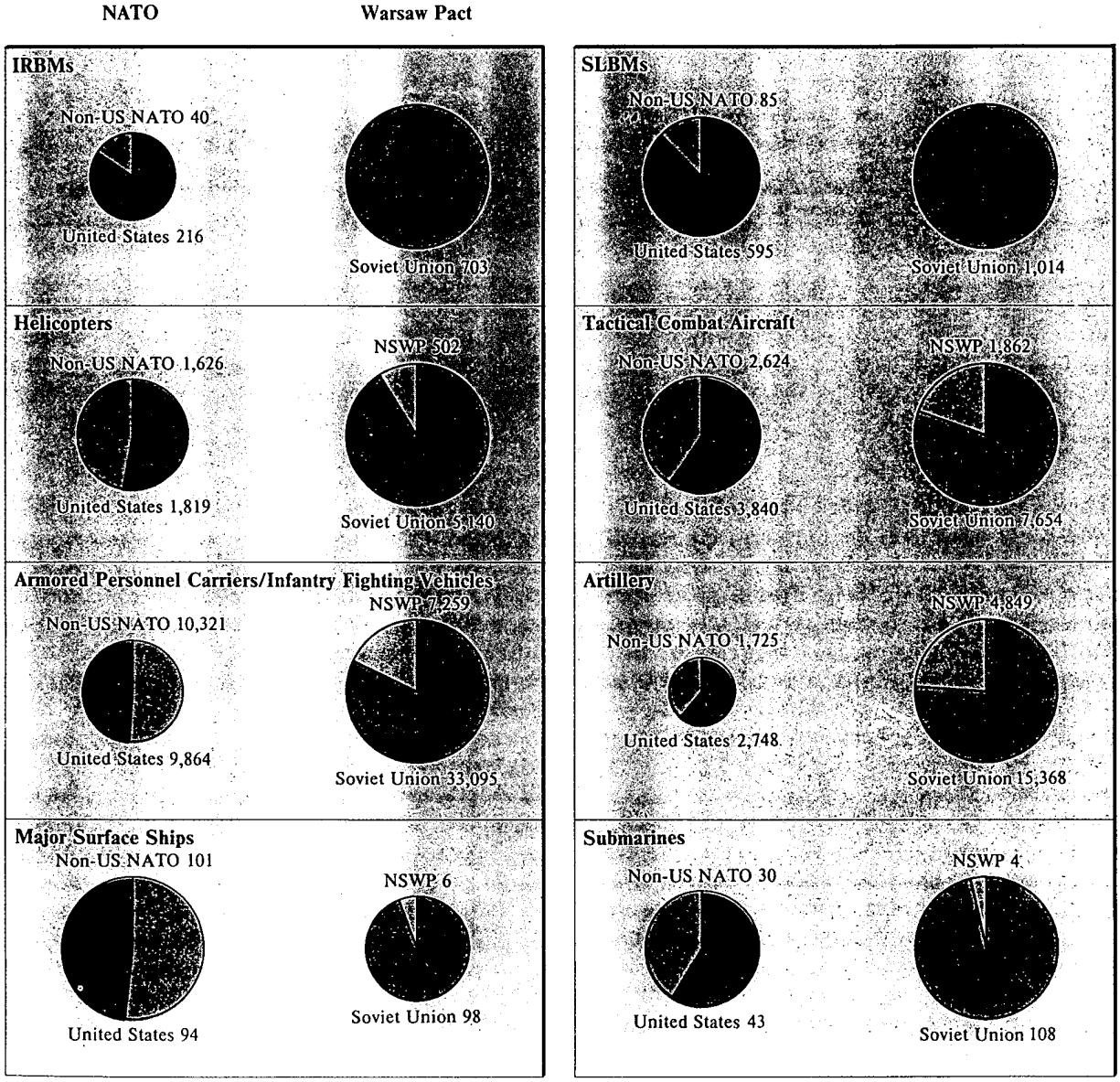
NATO, on the other hand, places a heavy emphasis on personnel and unit readiness and, hence, maintains a high level of training. For example, NATO's standard for minimum flight hours for tactical combat aircraft is 180 hours per year, while in the Warsaw Pact the average is less than 100 hours per year. In comparison with Pact practice, NATO training also tends to be more sophisticated, involving more realistic and complex combat scenarios and greater use of advanced simulation equipment. In addition, NATO training activity levels are higher because some of the NATO countries have higher turnover in military personnel resulting from conscription cycles that are about 50 percent shorter than those in the Pact.

Manpower

In 1986 Warsaw Pact and NATO military manpower levels were roughly equal at approximately 5.7 million and 5.3 million men [7] (see figure 4). The Soviet Union

[7] We include only those Soviet personnel who fill what in the United States are considered to be national security roles. Thus, for the Warsaw Pact, we do not include military personnel assigned to the militarized security forces of the Ministry of Internal Affairs, military construction and railroad troops, or civil defense troops.

Figure 3
Warsaw Pact and NATO Acquisition of Selected Classes of Weapon Systems, 1976-86



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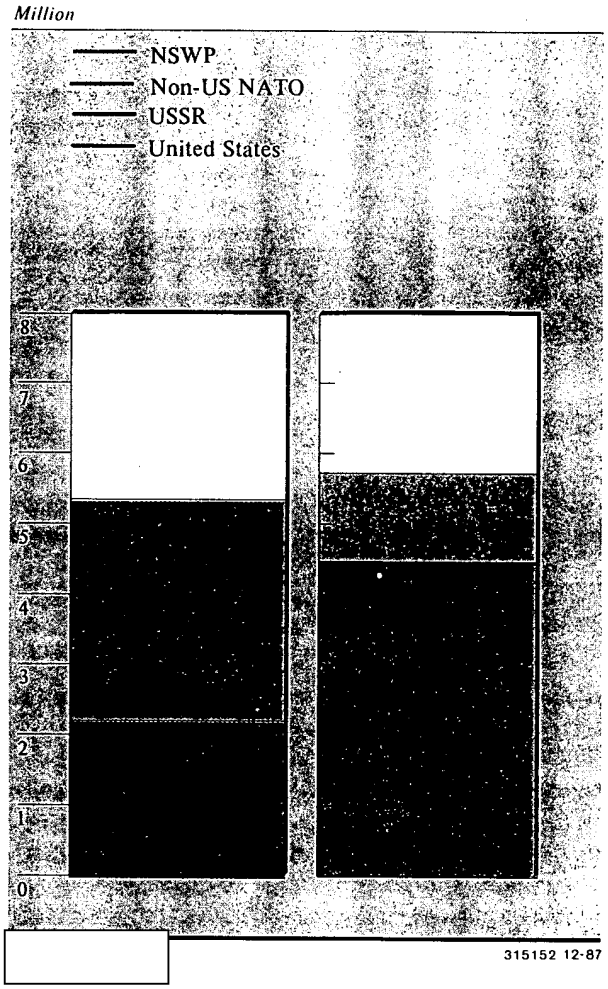
provided almost 80 percent of total Warsaw Pact manpower—some 4.5 million men. Poland was the next largest contributor with more than 400,000 men, followed by East Germany with over 200,000. Within NATO, by contrast, non-US NATO forces made up about 60 percent of the Alliance manpower total—some 3.1 million men. The United States had the largest force—2.2 million men—and Turkey was the next largest contributor with 750,000 men (see table 3).

Figure 4
Warsaw Pact and NATO Manpower Levels, 1986



Dollar Value of Defense Activities

The major differences in the weapons acquisition and readiness strategies of the two alliances are reflected in the differing dollar values of their respective defense activities. This section compares the dollar value of Warsaw Pact and NATO defense activities in the aggregate and by resource category—investment; operating; and research, development, testing, and evaluation (RDT&E).

Trends in the Dollar Value of Total Defense Programs

Throughout the 1976-86 period, the dollar value of NATO's defense activities and programs exceeded the estimated dollar value of comparable Warsaw Pact activities and programs. The difference between the totals for the two alliances increased from about 5 percent in 1976 to more than 25 percent in 1986 as the NATO total rose 3 percent per year while the Pact total grew at a fairly steady annual rate of 1 percent. We estimate that the total dollar value of NATO defense activities in 1986 was $378 billion in constant 1985 prices, compared with $297 billion for the Warsaw Pact (see figures 5 and 6).

Within the Warsaw Pact, the non-Soviet countries' share of the dollar value of defense programs has remained relatively level over the 1976-86 period at 15 percent. Among NSWP countries, Poland was the leader and East Germany and Czechoslovakia were next with almost equal totals. Together, these three northern-tier countries accounted for two-thirds of the NSWP total (see inset, p. 12).

In contrast, the non-US NATO countries play a much more prominent role in NATO. Over the period, the dollar value of their activities accounted for about 40 percent of the NATO total. This share declined, however, from about 43 percent in 1976 to 34 percent in 1986 because of the rapid increase in US programs after 1980. Within non-US NATO, the defense totals

Table 3
Warsaw Pact and NATO Military Manpower by Country, 1986

Warsaw Pact	
Total	**5,723,800**
USSR	4,470,000
Poland	413,200
East Germany	221,500
Czechoslovakia	220,000
Romania	197,500
Bulgaria	120,400
Hungary	81,200

NATO	
Total	**5,345,800**
United States [a]	2,200,000
Turkey	750,000
Italy	520,000
France	495,000
West Germany	495,000
United Kingdom [a]	301,000
Greece	166,000
Belgium	92,900
Netherlands	91,000
Portugal	88,000
Canada [a]	81,600
Norway	36,500
Denmark	28,800

[a] All-volunteer forces.

of the United Kingdom, France, and West Germany were roughly the same and together represented about 60 percent of the non-US NATO total. The Turkish total, which was driven by the large number of men under arms, represented another 12 percent (see inset, p. 12). It should, however, be borne in mind that, as cited above, these estimates of the dollar value of defense activities in the non-US NATO and Warsaw Pact countries measure the relative sizes rather than what these countries spend on defense. To measure each country's defense expenditures relative to the size of its economy, indigenous currencies should be used (see inset, p. 13).

Comparison of Investment Trends

Investment activities can be divided into two categories:

- Procurement of weapon systems and support equipment, including major spare parts.
- Construction of military facilities.

In the 1976-86 period, the estimated cumulative dollar value of Warsaw Pact military investment was almost 10 percent greater than the dollar value of NATO investment. Over time, however, the difference between Warsaw Pact and NATO investment levels changed dramatically. In 1976 Pact investment was more than 65 percent higher than that of NATO, but by 1982 NATO had caught up, and by 1986 NATO investment in dollars exceeded that of the Warsaw Pact by 30 percent (see figure 7).

Underlying these changes in the comparative levels of investment in the two alliances were differences in investment's growth as well as in the growth of procurement, its major component. The estimated dollar value of Warsaw Pact military investment experienced almost no growth from 1976 to 1986, while that of NATO increased at an average rate of 8 percent per year. Procurement grew by 9 percent per year in NATO but remained stable in the Warsaw Pact. The dollar costs of NATO procurement—which

Figure 5
Warsaw Pact and NATO Defense Activities, 1976-86

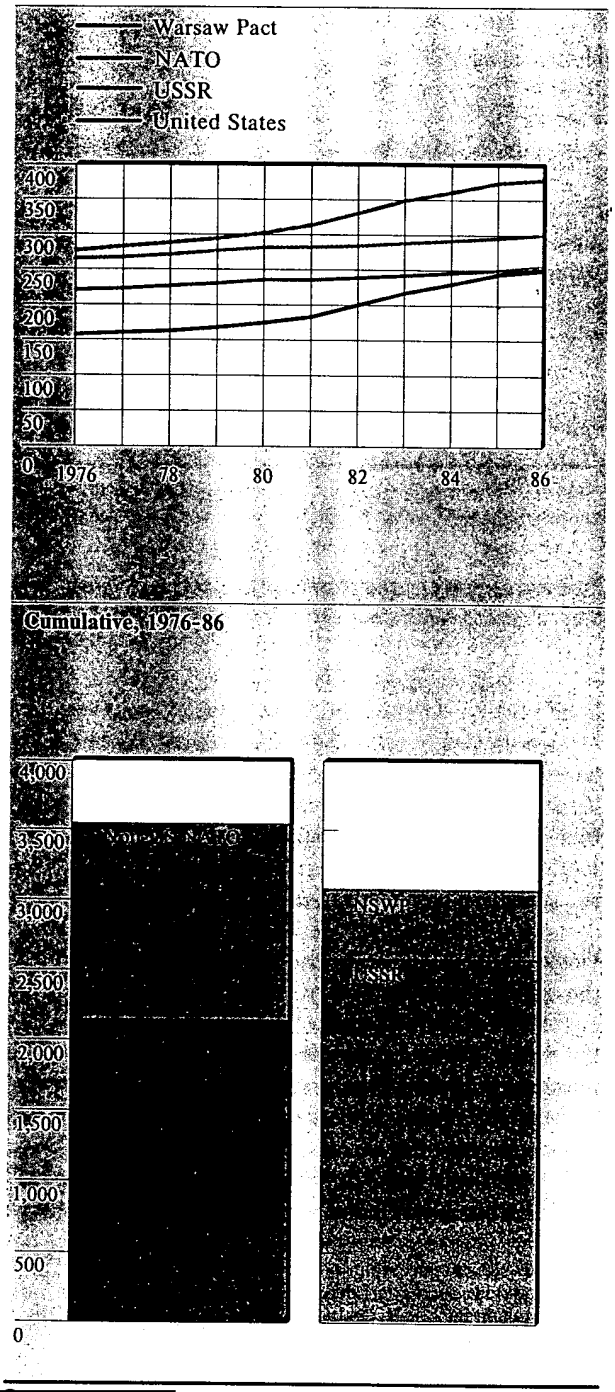
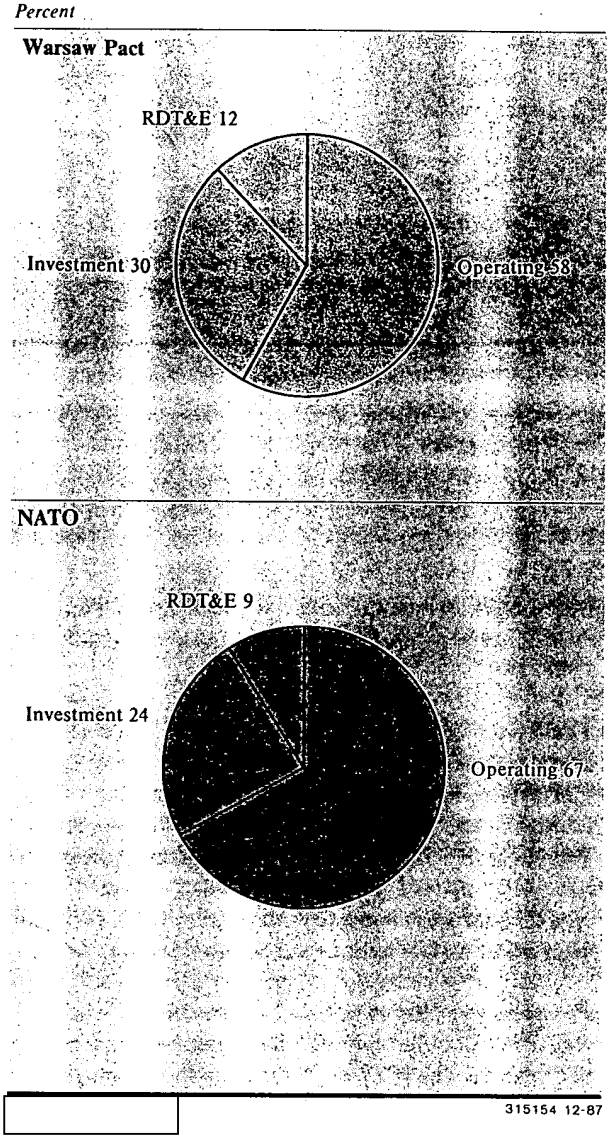


Figure 6
Distribution of Cumulative Costs by Resource Category, 1976-86



Shares of the Dollar Value of NSWP Defense Programs by Country, 1976-86 [a]

Country	*Share* (percent)
Poland	*30*
East Germany	*18*
Czechoslovakia	*18*
Romania	*16*
Bulgaria	*11*
Hungary	*7*

[a] *Excludes NSWP RDT&E because we are unable to estimate the dollar value of East European military RDT&E activities by country.*

Shares of the Dollar Value of Non-US NATO Defense Programs by Country, 1976-86 [a]

Country	*Share* (percent)
France	*21*
United Kingdom	*20*
West Germany	*19*
Turkey	*12*
Italy	*10*
Canada	*5*
Greece	*4*
Netherlands	*4*
Belgium	*3*
Portugal	*2*
Norway	*1*
Denmark	*1*

[a] *Because of rounding, data may not add to 100 percent.*

were much lower than those of the Warsaw Pact in 1976—exceeded the Pact's by almost 40 percent in 1986.

The Soviet Union accounts for a much larger share—almost 90 percent—of the estimated dollar value of military investment in the Warsaw Pact than the United States does in NATO—about 70 percent. While the NSWP share of Pact investment in dollars has been constant during the decade, the non-US NATO share has been declining since 1976, especially after 1980 as US outlays accelerated.

Procurement. Soviet military procurement, when measured in dollars, grew about one-half of 1 percent per year during 1977-86. This growth was markedly slower than in the previous decade when procurement increased at 3 to 4 percent per year (see figure 8). Growth since 1976 has been so slow that the dollar value of Soviet procurement has consistently remained roughly within the range of $62-65 billion per annum.[8] When measured in constant ruble prices, moreover, Soviet procurement displayed the same trend toward near-zero growth during the period.

While the dollar value of Soviet procurement was remaining roughly flat, East European defense procurement declined slightly. As was true for the USSR, the NSWP procurement trend during 1976-86 marked a break with earlier patterns except in Bulgaria where procurement growth measured in dollars remained the same (see table 4).

Dollar valuations also provide some general sense of the different mixes of weapons and equipment procured by the NSWP countries on the one hand and the Soviet Union on the other. Weapons—aircraft, missiles, ships and submarines, and land arms—account for almost 30 percent of total NSWP procurement valued in dollars; the remainder is accounted for by electronics,[9] support vehicles, and miscellaneous equipment. About 13 percent of the total goes

[8] For further discussion of the procurement slowdown, see DI Intelligence Assessment SOV 83-10135CX (Top Secret July 1983, *Soviet Defense Spending: Recent Trends and Future Prospects.*

[9] Includes electronic equipment not directly associated with a weapon system, such as air defense and other ground radars, tactical communications, testing and measuring equipment, and airfield electronic equipment.

Defense's Claim on National Resources in NATO and the Warsaw Pact

In addition to comparing the sizes of the defense programs of the member countries of the Warsaw Pact and NATO, it is often useful to compare the shares of gross national product that each country allocates to defense. To calculate such shares properly, it is necessary to use estimates of defense expenditures in domestic currencies rather than the estimated dollar values of defense activities.

Although we have the data required to estimate the shares of GNP allocated to defense in the NATO countries and the Soviet Union, our ability to estimate defense spending by NSWP countries in indigenous currencies is limited by data shortages. We have sufficient data to make such estimates for Poland, Romania, and Hungary, but only for selected years. We have insufficient data to estimate total defense spending in indigenous currencies in East Germany, Bulgaria, and Czechoslovakia. We are working on improving these estimates and hope to make in the future a more detailed comparison of the defense burdens of the two alliances.

Our analysis indicates that the share of GNP allocated to defense in the USSR is about twice as large as the US share; and that in the NSWP countries the defense share of GNP is generally larger than in most non-US NATO countries:

Percent

Warsaw Pact [a]		NATO [a]	
Soviet Union	15.8	United States	6.7
Romania	7.9	Greece	6.2
Poland	4.6	United Kingdom	5.0
Hungary	3.8	Turkey	4.8
Bulgaria	NA	France	4.0
Czechoslovakia	NA	Portugal	3.2
East Germany	NA	West Germany	3.1
		Netherlands	3.1
		Norway	3.1
		Belgium	3.0
		Italy	2.6
		Canada	2.2
		Denmark	2.0

[a] Shares are for 1986 with the exception of those for Romania (1975), Poland (1980), and Hungary (1980).

for aircraft, the largest single component of NSWP weapons procurement costs. Land arms and ammunition are the next largest with 10 percent of the total. For the USSR, in contrast, weapons account for about 60 percent of the estimated dollar value of procurement. The share of procurement accounted for by weapons as opposed to electronics and support equipment is greater in the USSR than in the NSWP countries because: (1) in addition to procuring land arms and aircraft, the Soviets also produce and procure large numbers of missiles and ships, two weapons categories that have a lower priority in the NSWP; (2) the Soviets acquire more modern and more costly weapons than do the NSWP allies; and (3) more generally, the Soviets made a stronger commitment to force modernization during the 1976-86 period than the other members of the Pact.

In NATO, US procurement outlays were the key driver in the growth of the dollar value of overall procurement. US procurement almost tripled in the 1977-86 period, increasing on the average by 11 percent per year. This rapid growth reflected an across-the-board modernization of military forces that emphasized the procurement of technologically advanced weapons. It also reflected decisions in the

Figure 7
Warsaw Pact and NATO Military Investment, 1976-86

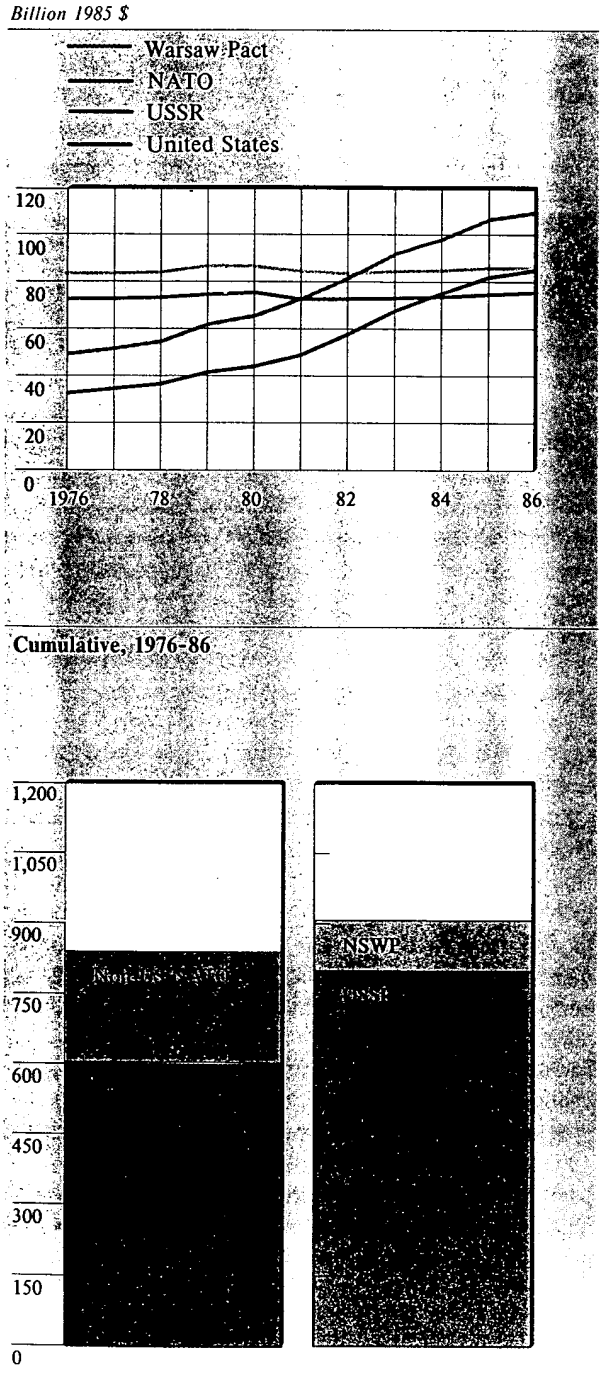


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Figure 8
Warsaw Pact and NATO Procurement, 1976-86

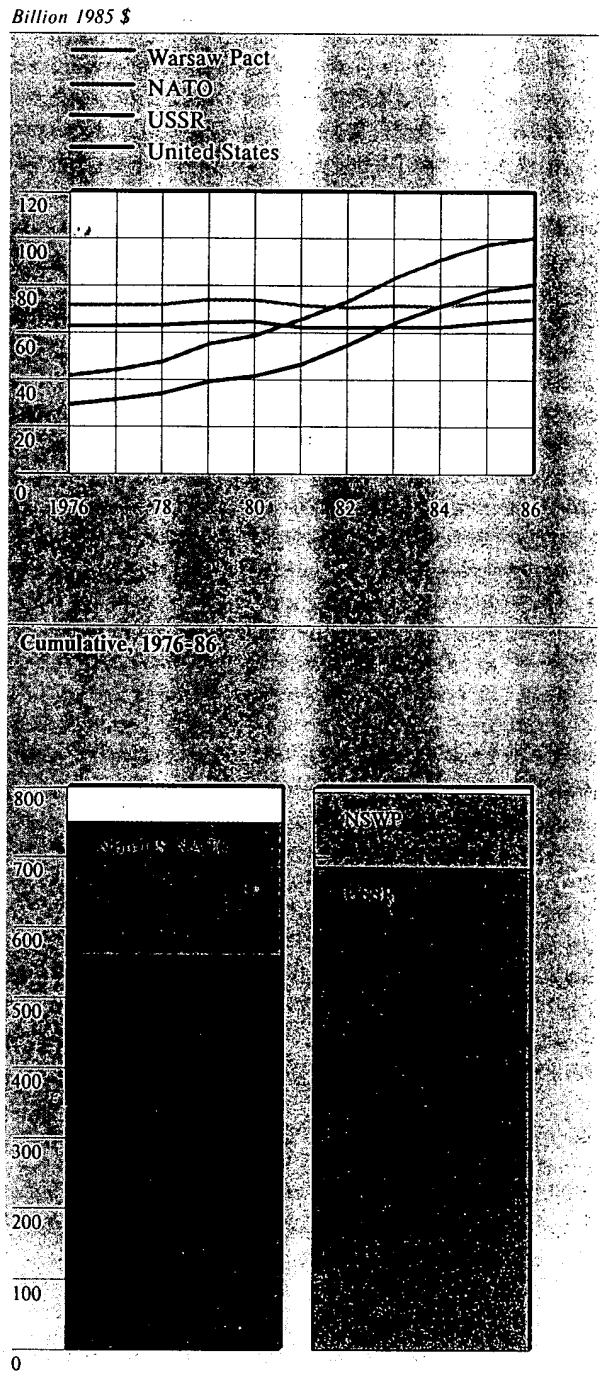

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Table 4
NSWP Procurement in Dollars, by Country

Average annual percent growth

	1971-75	1977-86
Total	3	−1
Bulgaria	2	2
Czechoslovakia	3	−1
East Germany	3	0
Hungary	8	−1
Poland	5	−2
Romania	5	3

early 1980s to improve the combat readiness and sustainability of US forces by building up reserve stocks of ammunition and major spare parts and to retrofit a substantial portion of existing forces.

During the 1977-86 period the dollar value of military procurement in the non-US NATO countries grew at a slower pace than comparable US outlays—on average, 5 percent per annum. This growth reflected the increased efforts by the Allies to procure new weapons and equipment in keeping with NATO's 1978 Long-Term Defense Plan (LTDP) as well as the more recently adopted Conventional Defense Improvement program (CDI).

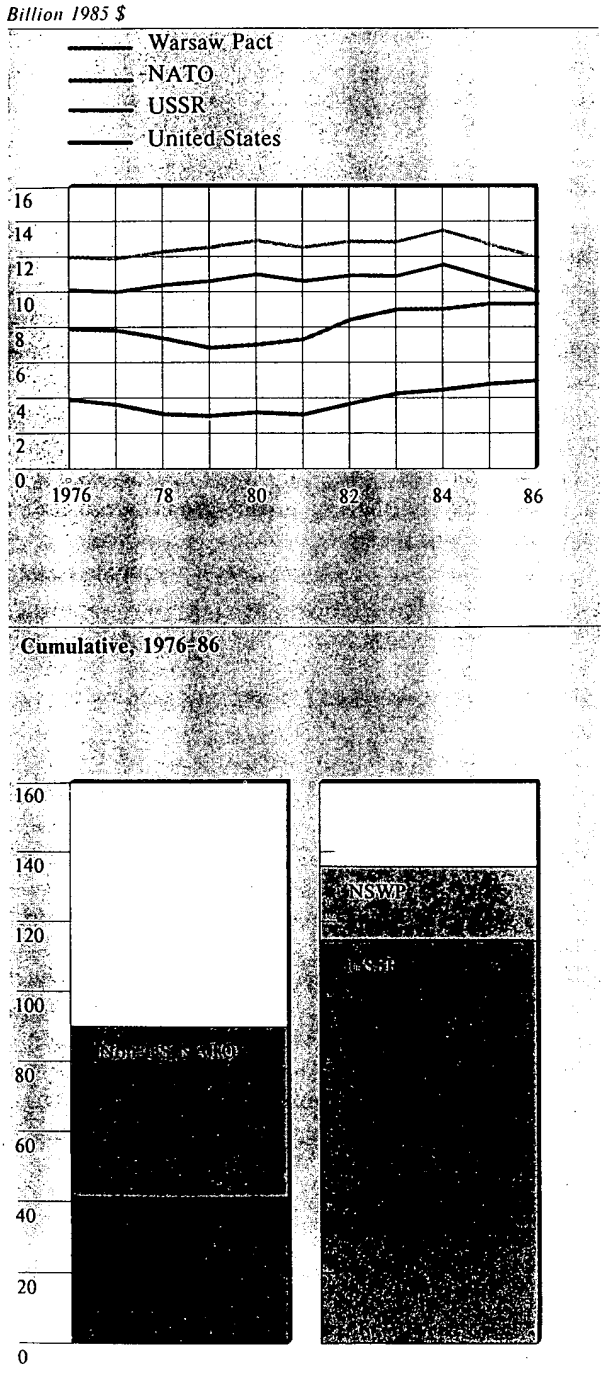
Despite this commitment to procurement, however, the Allies are currently cutting, postponing, or stretching out many major equipment modernization programs because of high costs:

- The British, Italians, and West Germans have stretched out their procurement of the jointly produced Tornado multirole aircraft.
- The Belgians continue to delay decisions on the purchase of the Patriot surface-to-air missile system and antiarmor helicopters.
- Norway has delayed its plans to modernize its 13 brigades by 1990 and has curtailed the planned modernization of its submarine forces.
- France has stretched out or delayed most of its major conventional forces programs, including the procurement of Mirage 2000 interceptors, new tanks, new artillery, and new armored vehicles.
- The West Germans have postponed development of a follow-on main battle tank.

Cumulative procurement by the Warsaw Pact and NATO since 1976 has been roughly comparable, when valued in dollars. The Pact, however, as noted above, produced more weapons than NATO in almost every major category. This apparent paradox is explained by the mix and quality of the weapons that the two alliances bought. As the comparisons in appendix C suggest, Soviet equipment procured during much of the period was generally of much simpler design and therefore considerably less costly than comparable US and West European equipment. Soviet tactical combat aircraft, for example, are primarily single-mission aircraft that lack many of the capabilities of US combat aircraft, such as the ability to conduct look-down/shoot-down operations against multiple targets. Although some new Soviet weapon systems such as the MIG-31 Foxhound, the MIG-29 Fulcrum, and the SU-27 Flanker aircraft are more comparable in complexity and cost to the latest Western systems, they made up only a small percentage of Warsaw Pact inventory during the 1976-86 period.

Another reason that the Pact has produced more weapons than NATO while the overall dollar value of procurement was roughly the same is that since 1980 the United States has been investing heavily in procurement categories other than weapons. In particular, the United States has made a major effort to improve the combat readiness and sustainability of its tactical forces by increasing its war reserve stocks of munitions and major spare parts and acquiring sophisticated training equipment. Comparisons of NATO and Warsaw Pact production of major weapons do not capture the value of these programs and others undertaken by the Alliance, such as retrofitting older aircraft with improved avionics and weapon systems. The Soviets generally have not retrofitted older aircraft with new equipment but rather have chosen to begin series production of a modified version.

Figure 9
Warsaw Pact and NATO Construction, 1976-86



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Construction. When measured in US dollars, construction is the smallest of the major military resource categories in both the Warsaw Pact and NATO. The dollar value of military construction makes up 4 percent of the total dollar value of Pact defense activities and 3 percent of the NATO total. Over the 1976-86 period, Warsaw Pact military construction totaled almost $140 billion, while NATO's totaled about $90 billion. The dollar value of Pact military construction experienced no growth over the decade; NATO's, in contrast, increased on average by 2 percent per year (see figure 9).

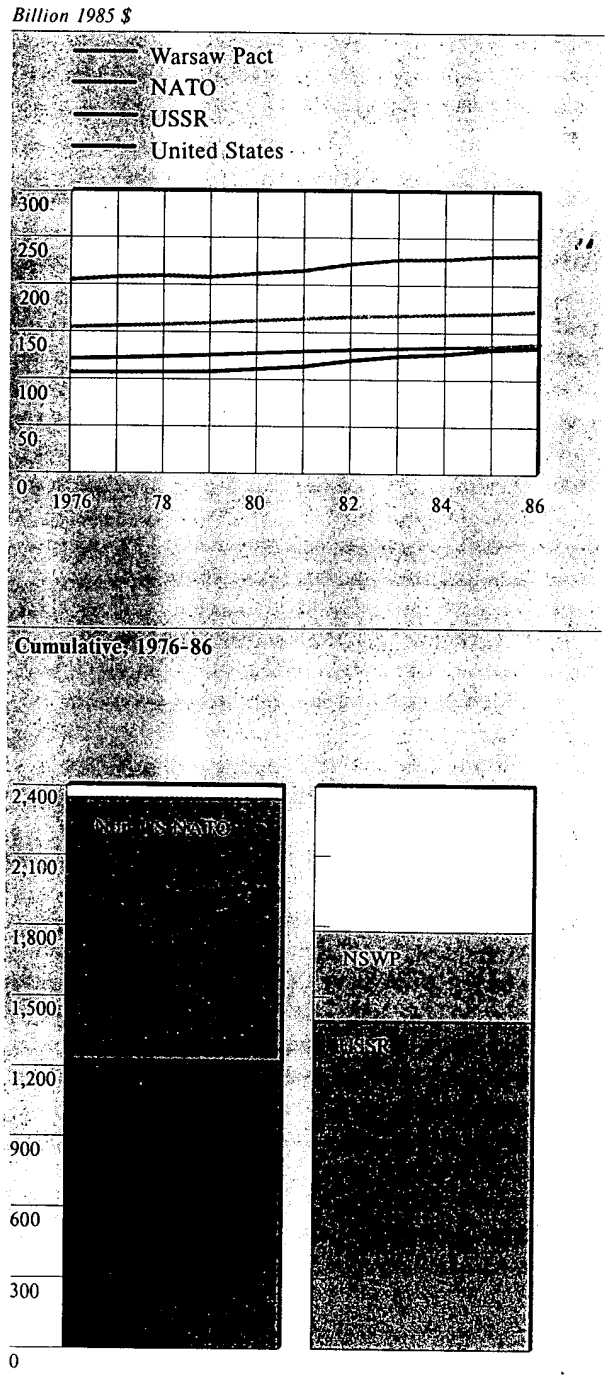
In both the Warsaw Pact and NATO, growth in the dollar value of military construction displayed distinctly different trends before and after 1981. The dollar value of construction activities in the Warsaw Pact grew on average almost 2 percent per year during 1977-80 but declined slightly between 1981 and 1986. Soviet construction, which grew over 2 percent per year from 1976 to 1980 and declined after 1981 when measured in dollar terms, was the major determinant of the Warsaw Pact construction trend. The rise in Soviet military construction during the 1976-80 period resulted from the modernization of missile sites, construction of command and control facilities, and the expansion of support infrastructures for the ground and naval forces. The decline in the 1980s was caused by the stabilization in the size of Soviet military forces, requiring smaller scale construction of support, housing, and weapon facilities. In NATO, the value of construction declined on average by almost 3 percent per year from 1976 to 1980 and increased 5 percent per year during 1981-86. The accelerated growth was a result of both US and non-US NATO construction growth after 1981 as the Allies increased investment in NATO infrastructure programs such as the hardening of aircraft shelters and command and control facilities.

Comparison of Operating Activities

Operating activities comprise two categories:

- O&M—the operation and maintenance of military equipment and facilities and the services provided by civilian personnel.
- Personnel—the pay and allowances, food, and clothing provided to active and reserve military personnel.

Figure 10
Warsaw Pact and NATO Operating Activities, 1976-86



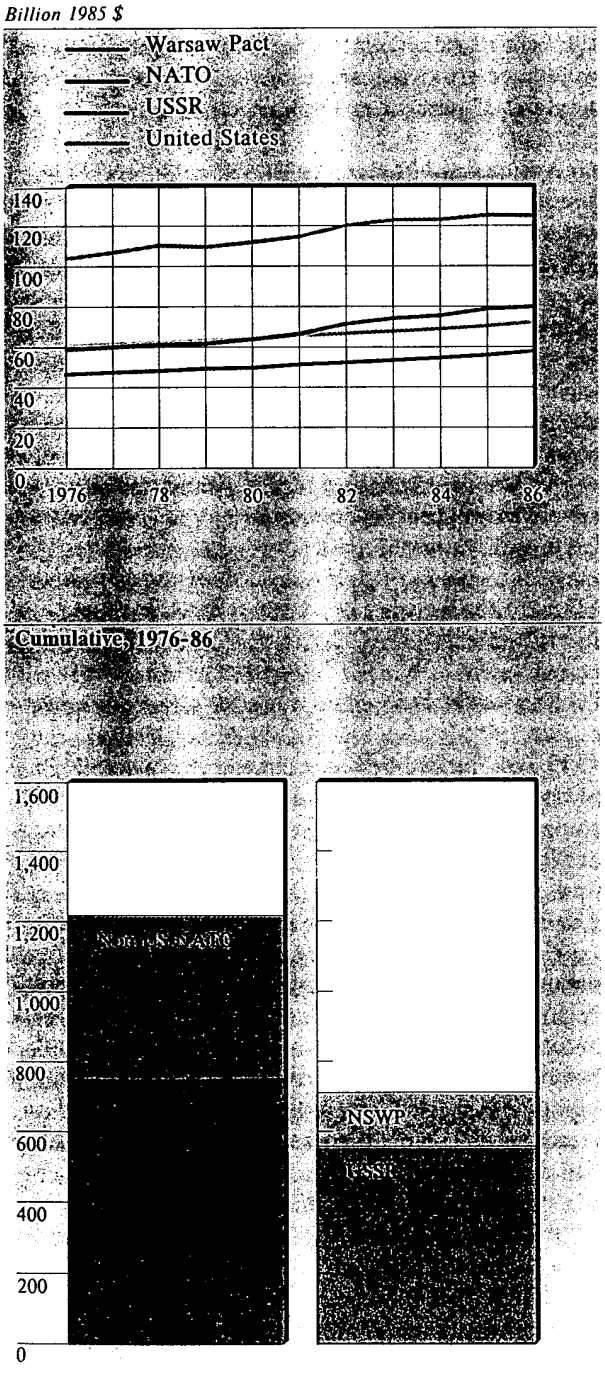
The estimated cumulative dollar value of NATO operating activities was about 33 percent—$585 billion—higher than comparable Warsaw Pact costs during the 1976-86 period (see figure 10). NATO operating activities valued in dollars were higher than the Pact's throughout the decade, with the margin of difference growing from just over 30 percent in 1976 to about 35 percent in 1986.

Operations and Maintenance. Although NATO has a smaller inventory of weapon systems, its O&M activities are substantially greater than the Pact's. Estimated cumulative NATO operations and maintenance activities valued in dollars were 76 percent higher than comparable activities for the Warsaw Pact during the 1976-86 period (see figure 11). They were higher for two main reasons: NATO's operating philosophy calls for higher operating rates and more intensive personnel training than does the philosophy of the Warsaw Pact, and NATO maintains more advanced weapons, which require more costly spare parts.

Much of the growth in NATO's O&M was due to increasing US outlays, which accounted for almost 60 percent of total NATO O&M. US expenditures for O&M grew at an average rate of 3 percent per year during 1977-86. US O&M growth accelerated after 1980 and climbed by 4 percent per year as the United States made a determined effort to upgrade the combat readiness and sustainability of its forces by undertaking more extensive maintenance of its military equipment, particularly tactical combat aircraft. The dollar value of non-US NATO O&M activities experienced almost no growth on average during the period and actually declined after 1983. This was due in part to a general rise in procurement costs at a time of limited budget growth. In addition, most non-US NATO countries curtailed their operating activities in response to the steady rise in energy costs. O&M valued in dollars continued to rise, however, as the Allies were faced with the maintenance of increasingly sophisticated weapon systems.

A major reason the Pact's O&M costs are lower than NATO's is that the Pact weapons inventory is made up of generally less complex systems that are less costly to operate and maintain than NATO's and

Figure 11
Warsaw Pact and NATO Operations and Maintenance, 1976-86



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require fewer costly spare parts. Pact inventory, moreover, is highly standardized among the member countries, eliminating the need for multiple O&M logistic structures. The NATO countries, in contrast, are forced to develop redundant O&M infrastructures because the Alliance operates a much wider variety of systems designed for similar roles than the Pact, thus increasing its requirements for spare parts and training.

The two alliances, as noted above, also differ in their approaches to training. The Pact armed forces emphasize preserving equipment at high levels of readiness and therefore operate their weapons much less than NATO. The NATO countries rely more on personnel and unit readiness and therefore train and exercise more than the Pact despite recent cutbacks in training. For example, NATO pilots generally fly two to three times as many hours as their Pact counterparts.

Some NATO countries, faced with tight budgets, have curtailed training in the active forces, strictly limited the use of fuel, and phased out older weapon systems without replacing them in order to reduce maintenance. The Belgians, Danes, Dutch, and Italians limited pilot flying hours to levels below the NATO minimum of 180 and far below the standard of 240 hours. Every country has canceled some ground forces field training exercises, and those exercises that do take place are often subject to strict limits on fuel usage.

Personnel. Trends and levels in the dollar value of personnel-associated activities in the Warsaw Pact and NATO followed very similar patterns during the 1976-86 period. This is not unexpected, given that the number of men on each side was almost the same and we assign the same pay rates to NATO and Pact personnel performing the same functions (see appendix A). If we count only those personnel who occupy positions that the United States classifies as fulfilling national security roles, by 1986 the Pact and NATO had roughly the same number of men in their military forces—5.7 million and 5.3 million, respectively (see

Figure 12
Warsaw Pact and NATO Personnel Costs, 1976-86

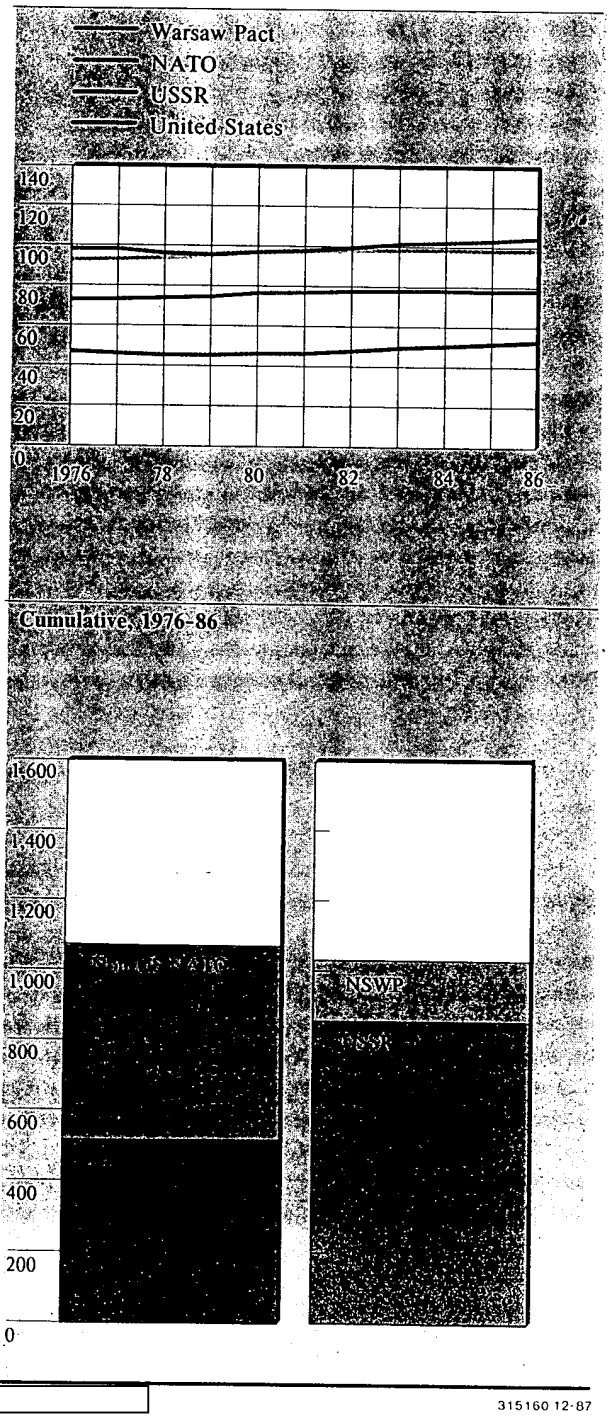


table 3). The cumulative total dollar value of supporting these establishments for the two alliances was virtually identical—about $1.1 trillion. Military personnel accounted for similar shares of the total dollar value of defense costs in the Pact and in NATO—35 and 30 percent, respectively. The growth of personnel-related activities in both alliances was also similar—less than 1 percent per year on average (see figure 12).

It should, however, be borne in mind that, unlike estimates of the dollar cost of weapons and military equipment, which take account of differences in technical and performance characteristics, the estimated dollar costs of military personnel assume that all personnel performing the same functions are of equal quality. Even within a single country's military force this assumption is unlikely to be true, but in the absence of generally agreed-upon "quality adjustment" factors there is no alternative to making this simplifying assumption.

Research, Development, Testing, and Evaluation

During the 1976-86 period, the estimated cumulative dollar value of Warsaw Pact RDT&E exceeded that of NATO RDT&E by almost 15 percent. Pact RDT&E costs exceeded those of NATO throughout the period. They grew 4 percent per year over the 1977-86 span, while NATO's rose 5 percent per year on average as rapid growth in US RDT&E offset slower growth in non-US NATO RDT&E

During the 1977-86 period, the dollar value of Soviet military RDT&E—almost 15 percent of the total dollar value of the Soviet defense effort—increased on average over 4 percent per year as the USSR continued its longstanding commitment to a large and growing RDT&E establishment. Since 1976, Soviet resources committed to the development and acquisition of key advanced technologies—including microelectronics and advanced manufacturing systems—appear to have grown even faster than the resources committed to the development of individual weapons. Floorspace devoted to Soviet military RDT&E between 1976 and 1986 increased at an average rate of

more than 3 percent per year. Total manpower involved in military RDT&E increased over the period at an average rate of about 3 percent per year, somewhat faster than during the 1966-76 period. In 1986 the Soviets employed about 3 million people to support their military RDT&E activities.

Although we do not have the necessary data to calculate the dollar value of military RDT&E of each NSWP country, we made an estimate of the dollar value of military RDT&E activities for the NSWP as a whole (see appendix A). We estimate that the cumulative value of NSWP RDT&E during the period was about 17 billion—some 3 to 4 percent of total NSWP defense activities. To a large extent the NSWP countries rely on Soviet weapons technology, either through purchases of Soviet weapons or licensing agreements under which they produce Soviet-designed weaponry. Although the East Europeans, especially the Romanians, design some weapon systems, these are generally less sophisticated land arms, support equipment, engineering equipment, and general purpose vehicles. The contribution of the NSWP military RDT&E effort to the Warsaw Pact, therefore, is smaller than that of non-US NATO to the overall NATO RDT&E effort. The inset shows the area of military RDT&E in which each NSWP country specializes.

In NATO, resources committed by the United States to RDT&E—almost 80 percent of the total dollar value of NATO RDT&E—grew on average by almost 6 percent per year during 1977-86. Growth accelerated from about 2 percent per year in the late 1970s to 9 percent per year in the early 1980s. This growth was attributable primarily to a major effort to improve strategic forces and to the application of microelectronics to the enhancement of conventional weapons. Non-US NATO RDT&E, valued in dollars, increased on average by 1 percent per year during the 1977-86 period. Unlike US RDT&E, non-US NATO RDT&E grew faster in the late 1970s than in the 1980s. It rose 4 percent per year during 1977-80 as the Allies tried to increase their technological capability and placed additional emphasis on their technological independence from the United States. In the 1980s, however, RDT&E costs experienced almost no growth as West European governments limited

NSWP Focus in Military RDT&E by Country

Country	*Principal RDT&E Focus*
East Germany	*Electronics, optics.*
Poland	*Helicopters, land arms.*
Czechoslovakia	*Land arms, trainer aircraft.*
Hungary	*Land arms.*
Romania	*Aircraft, tanks, APCs, ships.*
Bulgaria	*Land arms.*

RDT&E resources allotted to the defense ministries because of economic difficulties.

Many of these R&D activities were redundant as NATO developed four different main battle tanks, four different fighter aircraft, and numerous armored vehicles. Research activities vary greatly among the Allies. France, West Germany, and the United Kingdom develop systems in most major categories including fighter aircraft, missiles, land arms, and ships. The smaller countries have capabilities in specific areas such as small arms (Belgium) and electronics (the Netherlands). Greece, Turkey, Denmark, and Portugal have very limited RDT&E capabilities.

Outlook

In the absence of major changes in East-West relations and domestic economic and political conditions, recent trends in Soviet and NSWP defense activities—as reflected in our estimates of their dollar value—are likely to continue through at least 1990. If, however, the international environment or domestic economic conditions should change, the Soviets might well alter their present plans. For example, if General Secretary Gorbachev's campaign to modernize the economy falters, the Soviet leadership will face tough decisions regarding priorities, and some military programs may well be slowed or canceled to

divert resources to nonmilitary production. But even reduced levels of procurement would permit substantial continuing military modernization.

Soviet Union

The Soviet leadership's continuing efforts to modernize obsolescent industrial plant and equipment will require the allocation of scarce, high-quality resources—once the near-exclusive preserve of the defense sector—to civilian economic uses. Nonetheless, because Soviet defense industries have already undergone substantial modernization in the late 1970s and early 1980s, they are well positioned to meet the Soviet armed forces' weapons needs during the current (1986-90) five-year plan. On the basis of available evidence on the pace of major weapons development and production programs, we believe that deliveries of arms and military equipment to Soviet forces will continue at the high levels maintained since 1976. Such levels of procurement are likely to translate into substantial across-the-board modernization of Soviet forces.

A comprehensive modernization of the USSR's strategic offensive forces should be completed by the early 1990s. Strategic defense force improvements, although less substantial, also will permit sustained improvements in capabilities. The Soviets will improve their ability to defend against cruise missiles and low-altitude bombers with such systems as the SA-10 missile and lookdown/shootdown aircraft such as the MIG-29, MIG-31, and SU-27.

Soviet conventional forces will also be upgraded. The Air Forces are receiving the MIG-29 and the SU-27, and the Navy will get new submarines and warships—including the USSR's first full-size aircraft carrier. Meanwhile, a variety of improved land arms, most notably the T-80 tank and new artillery weapons, many of which are superior to Western systems, are being deployed with the Ground Forces.

NSWP

The Soviets have been exerting increasing pressure on the NSWP countries to improve and expand their weapons inventories. Since the mid-1970s, however, the gap between Soviet and NSWP forces has widened, especially in terms of quality. Most disturbing to the Soviets is the fact that NSWP forces are falling behind in categories of equipment most critical to the Soviets' conventional strategy. The NSWP countries face a dilemma in modernizing their inventories because of adverse economic conditions and the skyrocketing costs of modern weapon systems. Up to now, the East Europeans relied on the acquisition of models of equipment that were old by Soviet standards in expanding their forces. In the future, they will be expected to purchase more modern—and more expensive—arms. Because additional resources for defense will be hard to come by, the NSWP countries will have to replace most older systems at a slower rate than in the past, cut other defense activities in favor of procurement, or buy older systems, all despite Soviet concerns over lagging NSWP military capabilities.

Non-US NATO

Although the Allies have made substantial improvements in their armed forces, including the modernization of ships, aircraft, and armored vehicles, cuts and delays in defense procurement programs have forced most of them to continue using older equipment. The countries of NATO's Central Region have been the most successful in modernizing their forces, while those on the northern and southern flanks have lagged well behind.

Economic problems and political pressure against defense budget growth have eroded the willingness of non-US NATO governments to make major improvements in their defense programs. Most Allies will continue to try to counteract substantial budget deficits by curtailing government expenditures, and defense efforts will take their share of the cuts. With high unemployment expected to persist into the 1990s, we believe it unlikely that the non-US NATO countries as a whole will make any major increases in their defense programs. In fact, a number of countries have announced plans for little or no growth in programs through the end of the decade. The Allies are likely to cancel major acquisition programs, curtail other activities (particularly in O&M), or slow deliveries to

offset the increased costs of new weapon systems. Delays and cuts by some allies, particularly Belgium, Denmark, Norway, and Canada, will make it increasingly difficult for them to fulfill their NATO commitments. This could force other Allies to compensate by increasing defense activities or face a general decline in NATO defense capabilities.

United States

The United States is currently involved in a major program to modernize and expand its forces. Programs outlined in the Secretary of Defense's *Annual Report to Congress, Fiscal Year 1988* call for further improvements of the three military services. The Army will continue to receive M-1 Abrams tanks, which are being upgraded with a 120-mm gun, as well as additional Bradley armored fighting vehicles. A substantial number of AH-64 Apache attack helicopters also will be introduced into the force. In the next several years the Navy will be acquiring two additional Nimitz-class aircraft carriers and will complete the reactivation of four Iowa-class battleships. The rest of US naval forces will be modernized as well with the introduction of new cruisers, destroyers, and attack submarines. Navy air assets will be expanded with substantial numbers of F/A-18s, AV-8Bs, and additional F-14Ds, and the Navy's strategic capabilities will be improved with the deployment of the Trident II D-5 missile. The Air Force will continue to receive modernized F-15s and F-16s. US strategic nuclear forces will be improved with the introduction of the Peacekeeper missile and the new B-1B bomber.

Appendix A

Direct Dollar-Costing Methodology for Warsaw Pact Defense Programs

Estimates of Warsaw Pact defense activities expressed in dollars measure the cost, using prevailing US prices and wages, to produce and man a military force of the same size, armed with the same weapons, and operated in the same manner as that of the Warsaw Pact.

Definitions

In this paper, defense activities are defined to include the following US activities and their counterparts in Warsaw Pact and non-US NATO countries:

- National security activities funded by the Department of Defense.
- Defense-related nuclear programs funded by the Department of Energy.
- Selective Service activities.
- The defense-related activities of the Coast Guard.
- Military pensions.

In addition, they include border security forces that have a wartime mission of border defense, premilitary training performed by civilian schools, and pay for reservists funded by civilian enterprises.

They exclude:

- Civilian space activities that in the United States would be performed by the National Aeronautics and Space Administration.
- Military assistance to foreign nations (except for the costs of uniformed personnel) and military sales.
- Civil defense programs.
- Internal security or uniformed labor troops who do not have wartime defense missions.
- The cost of increasing and maintaining stockpiles of reserves such as fuel, spare parts, and raw materials.
- Industrial mobilization preparations.
- Dual-use infrastructure such as communications lines, reinforced bridges, and wider roads.

The costs of stationing Soviet troops in NSWP countries are considered part of Soviet defense costs, although there is some evidence that host countries provide support in the form of infrastructure and subsidized prices on supplies sold to Soviet contingents.

These definitions are similar to those NATO uses to monitor defense spending of its member countries. The definitions of resource categories also resemble NATO's, although NATO has a narrower definition of RDT&E costs.

Methods

We develop the dollar values of all Warsaw Pact defense activities by identifying and listing distinct components of the forces such as individual classes of surface ships, ground forces divisions (divided into categories on the basis of type and readiness level), and air regiments (categorized by aircraft type for each service). Our listing also contains for each component our estimates of order of battle, manning levels, equipment inventories, and new equipment purchases. To these detailed estimates of activities, we apply appropriate US prices and wage rates.

Procurement in dollars represents estimates of the cost to manufacture Warsaw Pact weapons and equipment in the United States using prevailing prices for materials and labor (including overhead and profit) and US manufacturing technology. We use the same average unit dollar cost derived for Soviet procurement to estimate the dollar value of procurement of the same item for the NSWP inventory. Because most NSWP equipment is one or more design generations behind Soviet equipment, we have had an opportunity to thoroughly research these cost estimates and we consider them quite reliable

Our estimate of procurement of support equipment [10]—which accounts for roughly one-half of total procurement in the Warsaw Pact—is more uncertain than our estimate of procurement of major weapon systems because the support category is difficult to monitor on an item-specific basis as is done for procurement of weapon systems. (

Operations and maintenance (O&M) cover the cost of labor, materials, spare parts, overhead, and utilities required to operate and maintain equipment the way the Pact does. We calculate Soviet O&M costs as a percent of the procurement cost of a particular weapon; the percent is based on operating rates and costs of spare parts. Except for land arms, for which operating rates are adjusted for known differences in levels of readiness, we assume that NSWP and Soviet O&M practices are the same. This is a good assumption for maintenance practices because NSWP equipment is Soviet designed or produced, but a weaker assumption for operating practices because NSWP training and exercise rates differ from those in the Soviet Union. Although we know that NSWP operating rates have declined since the mid-1970s, we are presently unable to estimate the extent of the decline. As a result, the estimates assume NSWP operating rates at the mid-1970s Soviet levels. Civilian pay is calculated by multiplying the number of civilian defense workers by the average pay of their US counterparts.

The dollar values of pay for Soviet personnel are based on the estimated rank of the person the United States would assign to carry out similar functions. The Soviet conscripts' rank, and thus dollar pay, is based on the rank of US personnel with the same average time in service. To account for the fact that the United States would use enlisted men for many positions in which the Soviets use officers, dollar pay for some Soviet officers is an average of US noncommissioned officer and commissioned officer pay. Separate estimates are made for food and travel costs.

[10] Includes electronics, vehicles, engineering equipment, naval supplies and equipage, organizational equipment, and aircraft ground support equipment. (

Because we do not have detailed data on NSWP rank structure, we were only able to apply US pay rates to categories of personnel rather than to each individual rank, as is done for the Soviet personnel estimates. The categories in each branch of service are officers, warrant officers, career enlisted men, conscript sergeants, conscript privates, and cadets.

Research, development, testing, and evaluation (RDT&E) costs for the Soviet Union are derived using a methodology that assigns ruble values to the resources used in Soviet military RDT&E activities.[11] These include wages, materials, equipment, capital repair, capital construction, travel, training, and other operating costs. The ruble values are then converted to dollars by using an average military procurement dollar-ruble ratio. The purpose of using a procurement dollar-ruble ratio is to reflect the different productivities of research and development resources in the two countries. In effect, we are assuming that the ratio of the dollar value of the research and development work performed in the Soviet Union to the ruble cost of these resources equals the ratio of the dollar value of military hardware produced in Soviet defense plants to the ruble cost of the resources employed in those plants. This approach is analogous to the purchasing power parity methodology used to convert non-US NATO defense expenditures to US dollars (see appendix B). RDT&E consists of all phases of programs and activities from research through full-scale testing and evaluation.

To estimate the dollar value of NSWP RDT&E activities we first estimated expenditures for military research and development in domestic currencies in the countries for which we had sufficient data to do so. We then computed the ratio of these estimated East European RDT&E expenditures to estimated military investment and operating expenditures in domestic currencies, and applied this ratio to our

[11] See DI Technical Intelligence Report SOV 86-10030 (Secret), July 1986, *Estimating Soviet Military RDT&E Expenditures.*

estimates of the dollar value of total NSWP investment and operating activities to obtain a dollar value of NSWP RDT&E.[12] We then added the estimated dollar value of total NSWP military RDT&E to the estimate of other NSWP defense activities.

Confidence in the Dollar Cost Estimates

Estimate of Soviet Programs

Every year we revise the estimate of the dollar value of Warsaw Pact defense activities using updated data on costs, production quantities, operating, and order of battle. Presumably, our estimates for any one year (for example, 1976) would improve as time passes because we should know more about the quantities and characteristics of the weapon systems and facilities produced in that year.

The annual revisions to incorporate new information provide a method of assessing how well we estimate the dollar costs of major portions of Soviet defense activities. If estimates for a given year changed sharply with every review—indicating that different analysts, improved data, and new methodologies produce very different results—we would have little confidence that we have an accurate estimate of military activities in that year. On the other hand, if the estimates fluctuated only by a small amount and no bias were detected, we could have greater confidence that the estimates were substantially correct.

Our experience in the past has been such as to make us reasonably confident of the accuracy of our estimates. Indeed, monitoring our annual revisions and other statistical techniques leads us to believe that our dollar cost estimate for total defense activities is unlikely to be in error by more than plus or minus 10 percent for any year from 1976 to 1986. The margin of error can be much wider for some individual items and categories than for the total because of the tendency of errors at lower levels of aggregation to be partially offsetting. We generally have more confidence in data that represent trends than in data for absolute levels, especially the levels for individual years.

NSWP Defense Cost Estimates

In general, our confidence in the estimate of the total dollar value of NSWP defense activities is at least as high as our confidence in the estimate of Soviet defense costs. Among the NSWP countries, however, our confidence varies. It is highest for the northern-tier countries and Hungary, and lowest for Romania and Bulgaria. Our lack of country-specific information on operating rates and our lower confidence in manpower estimates for Romania and Bulgaria make our cost estimates for those two countries more uncertain.

[12] *Joint Economic Committee, East European Economies: Slow Growth in the 1980s*, 1985, pp. 475-495.

Appendix B

Methodology for Estimating the Dollar Value of Non-US NATO Defense Programs

The quality of any comparison of two or more nations' defense activities depends in large part on the conversion factors used to record them in a common monetary unit. For this paper, the factors for non-US NATO expenditures had to be consistent with the factors used to convert Warsaw Pact expenditures from a domestic price base to a dollar price base. Otherwise, the resulting NATO–Warsaw Pact dollar comparison would be misleading. The most desirable method of deriving the dollar value of non-US NATO defense activities would have been to directly cost in dollars each piece of hardware, each man, and each activity—as was done for the Warsaw Pact forces. In fact, enough data were available to cost non-US NATO pay and allowances directly in dollars, and thus a considerable degree of consistency was achieved—in 1986 these categories accounted for half of the total dollar value of non-US NATO activities.

It was not possible, however, to use the direct-costing methodology for non-US NATO investment, O&M, and RDT&E given the very large research effort that would have been required. This appendix describes the development and results of a method to convert expenditures for these purposes from domestic currencies to US dollars. Our method has several steps:

- Obtain the Defense Program Questionnaire (DPQ) expenditure data for each NATO country in national currencies.
- Develop a set of appropriate conversion factors, which are applied to expenditures in national currencies at the lowest level of aggregation possible to produce estimates in dollars for the goods and services being compared.
- Apply disaggregated US defense price indices to remove inflation from the dollar estimate. To these constant dollar estimates, we add estimates of pay and allowances derived by applying US wage rates to NATO personnel.

Defense Expenditures in National Currencies

NATO's DPQ is the basic source of information on each country's defense expenditures expressed in national currencies. Its standardized format provides the best available assurance of consistent reporting. Every non-US NATO country except France uses the DPQ format, allowing us to convert to dollars at a low level of aggregation. For France, we used budget data broken down by major resource categories and converted aggregate subtotals for procurement (capital), operating costs, and research and development.

Developing Appropriate Conversion Factors

Problems With Using Exchange Rates as Converters

We did not use exchange rates as a basis for conversion for two main reasons:

- Exchange rates reflect one country's demand for another's currency, not the amounts of each country's currency required to ensure equivalent domestic purchasing power. One unit of a given country's currency may be exchangeable for one unit of another's, but the prices of equivalent goods and services in the two countries may still differ greatly.
- Use of exchange rates is especially inappropriate because of the misleading distortions caused by fluctuations that have occurred since the late 1970s under floating exchange rates.

Problems with the exchange rate method have led two primary users of non-US NATO dollar defense estimates—NATO and the US Department of Defense—to express dissatisfaction with it. Although NATO

uses it to develop expenditure totals in a common currency (US dollars), it warns:

> *Conversions of national data into a common monetary unit for purposes of comparison are not accurate to the extent that market exchange rates do not perfectly reflect the relative purchasing power of national currencies. In a period of monetary stability the effect of such anomalies is limited, but when there are marked fluctuations in exchange rates, as at present, the resulting distortions can seriously affect the relationship between countries.*[13]

The Department of Defense uses exchange rates to convert non-US NATO defense spending to dollars for its annual "burden-sharing" report to Congress as a way of measuring members' contributions.[14] The report states that another method would be more desirable but NATO has not yet developed one:

> *It is necessary to find a method to equalize exchange rate fluctuations. The most precise method devised to date is the Purchasing Power Parity (PPP) system . . . . The NATO international staff is constantly working on the problem of developing a better methodology to improve its price deflators. This will lead eventually to the development of an agreed PPP system for defense comparisons.*[15]

The PPP Concept

The best way to derive a representative conversion of the value of goods and services from one currency to another is to use a method that captures the relative prices of the same good or service in different countries. Such a method involves using the relative purchasing power of national currencies as measured by price ratios called purchasing-power parities. A PPP is an international price index indicating the number of units of a foreign currency required to purchase the same quantity of a good or service in that country as one US dollar will buy in the United States. A PPP may be expressed as the ratio of any two currencies. Most PPP studies, including work done in NATO, use dollars as a base currency; any other unit or money could be used but dollars are familiar to a wider audience.

The PPPs in This Study

We used PPPs from the general economies of the non-US NATO countries as proxies for military PPPs because of the lack of unique military PPPs. In the early 1980s the United Nations established a Group of Experts to study the feasibility of developing military PPPs. The Group concluded that to construct a useful set, countries would have to divulge extensive defense data. To date, not enough NATO countries have provided such data.

Our study is based on PPPs calculated for three benchmark years: 1975, 1980, and 1985. The source is the International Comparison Project (ICP) of the United Nations.[16] We interpolated between benchmark years according to the relative rates of inflation in each country using disaggregated GDP deflator indices from an OECD study.[17]

We tried to work at the lowest possible level of aggregation so that the match between a civilian PPP category and a DPQ category would be as close as possible (see the inset). When a DPQ category contained diverse activities and had no exact civilian PPP counterpart, we applied a PPP at a higher level of aggregation. This procedure ensures that, at a minimum, all the DPQ activities are covered.

Producing a Constant Dollar Series

Because each benchmark PPP represents prices and quantities at a particular point in time, they reflect current prices. A dollar estimate in current prices was

[13] NATO, *International Staff Memorandum*, ISM(84), 7 July 1984, p. 11.
[14] Department of Defense, *Report on Allied Contributions to the Common Defense*, March 1986.
[15] *Ibid.*, p. 130-31.
[16] See Kravis, Irving, et. al., *World Product and Income*, (Phase III), Johns Hopkins University Press, Baltimore, Md., 1982, and United Nations, *World Comparisons of Purchasing Power and Real Product for 1980* (Phase IV), UN, New York, 1986.
[17] OECD, *National Accounts, Main Aggregates, 1960-84*, Vols. 1 and 2, OECD, Paris, 1986.

Analog Purchasing-Power Parities (PPPs) From the UN International Comparisons Project (ICP)

PPPs	DPQ Category [a]
Aircraft	Aircraft, missiles [b]
Ships and boats	Ships and harbor craft
Trucks, buses, trailers	Transport vehicles
Electrical machinery	Missile support systems, electrical and communications equipment
Nonelectrical machinery	Artillery, weapons and small arms ammunition and explosives [c]
Construction, mining, and metallurgy equipment	Engineering and military road equipment, combat vehicles [d]
Clothing and footwear	Clothing
Food, beverages, and tobacco	Food
Purchased transport	Other personnel [e]
Other construction	NATO common infrastructure [f]
Construction	Military construction
Producer durables	Nonconcurrent spare parts, other equipment and supplies [g]
Fuel and power	Petroleum products
Gross fixed capital formation	Other operations and maintenance [g]
Gross domestic product	Other defense [g]
A weighted mix of civilian wages (60 percent) and gross fixed capital formation (40 percent)	Research, development, testing, and evaluation [h]

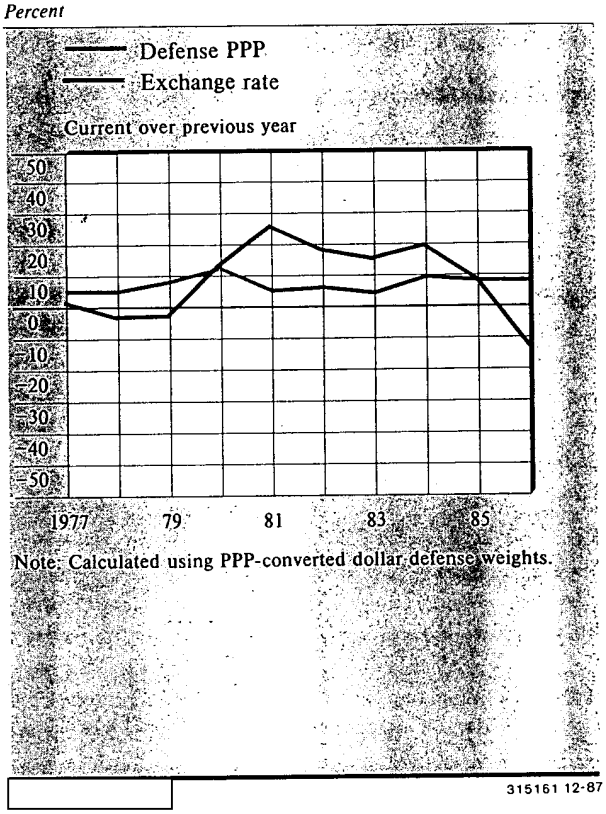
[a] *Department of Defense* Defense Planning Questionnaire.
[b] *Missile airframes and propulsion systems are similar to aircraft; electronic components of missiles are covered in the "electrical machinery" PPP category.*
[c] *These items consist of a wide variety of mechanical devices and materials similar to those found in civilian industrial machinery. To capture the relative values of these devices and materials, we applied the relatively aggregate "nonelectrical machinery" PPP.*
[d] *Production of combat vehicles is similar to the production of heavy road and construction vehicles used in civilian industry.*
[e] *The single largest expense in this category is for the transportation of military personnel.*
[f] *Includes nonbuilding construction such as runways, roads, and other engineering projects.*
[g] *For very diverse DPQ categories, we chose analogs that are broad enough to cover as much of the range of the goods as possible while retaining some degree of specificity.*
[h] *On average 60 percent of non-US NATO RDT&E costs consist of personnel expenditures and the remainder consists of materials.*

derived by dividing each NATO country's expenditures for investment, O&M, and RDT&E in current domestic prices by these PPPs. These figures were then converted to constant 1985 dollars using disaggregated US dollar price indices for military goods and services.

Assessment of the PPP Method

PPPs are better conversion factors for Warsaw Pact–NATO sizing comparisons than exchange rates because they are more representative of the goods and services being compared and do not fluctuate with changes in the currency markets. Figure 13 shows how much exchange rates and analog PPPs fluctuated in the period under study. The line showing the weighted average change in our defense PPPs is relatively flat and shows that the PPPs have increased fairly smoothly over the period, reflecting rates of inflation that are higher in the non-US NATO countries than in the United States. The fluctuations in the exchange rate line, on the other hand, portray changes in the relative sizes of countries' contributions to the common defense in ways unrelated to underlying trends in real growth in defense expenditures. For example, in 1979 the United Kingdom had the fourth-largest defense expenditures in NATO when measured in exchange rate–converted dollars. In 1980, however, the value of British defense expenditures increased in terms of the dollar, reflecting the appreciation of the pound relative to the dollar. Thus, British defense expenditures valued in dollars rose to second place within NATO with no appreciable increase in sterling defense outlays. Whereas the appreciation of the German mark and the French frank relative to the dollar was considerably less. Furthermore, the variation in exchange rates offset increases in German and French defense expenditures in domestic currencies that were larger than British spending increases expressed in sterling.

Figure 13
Average Annual Change in Exchange Rates and PPPs



Methods for Estimating NATO Military and Civilian Pay

Pay and allowances, a large portion of NATO defense expenditures, were priced directly in dollars without using PPPs. Military pay and allowances in dollars were based on the pay of personnel the United States would assign to carry out functions similar to those in non-US NATO military forces. The concept is to match pay to positions or jobs, not ranks. For each country, we estimated dollar pay rates for three categories of personnel: officers, career enlisted men, and conscripts. For civilian pay and allowances, we multiplied the annual number of civilians reported to the DPQ for each country by the average cost of pay and benefits for civilians—both direct and indirect hires—working for the US Department of Defense.

Officer Pay Rates

The dollar pay rates for NATO officers are based on the actual average pay and allowances received by US officers in fiscal year 1985. We obtained these data from the *Appendix to the US Budget FY 1987*, which reports personnel costs separately for officers and enlisted men, and subtracted subsistence costs. Dividing these by the number of US officers given in the Budget appendix and subtracting food, we calculated average pay and allowances per officer—about $28,500 per year in 1985.

Career Enlisted Pay Rates

Two career enlisted pay rates were developed. The first was for countries that, like the United States, have a volunteer military: the United Kingdom and Canada. This pay rate is the average actual pay and allowances for US enlisted men in FY 1985—about $15,000 per man. The second pay rate is for countries with conscription. Pay to career enlisted personnel in these countries was calculated as the average pay to all US enlisted personnel except E-1, E-2, and half of E-3 personnel. Average career enlisted pay was $16,700.

Conscript Pay Rates

The dollar pay rates for conscripts were chosen to reflect the different terms of conscripted service in NATO countries. For countries in which the average time in service is five to seven months, the US average E-2 rate was used. Conscripts with seven to 11 months' average experience got a weighted average of US E-2 and E-3 pay with the weights chosen so that the resulting implied average experience equals that of the NATO country's conscripts, using an average of six months for E-2s and 18 months for E-3s (see table B-1).

Adjustment for Personnel Practices

The US proportion of officers—14.2 percent—is higher than in most other Western countries. All NATO countries except Denmark use enlisted men to do some jobs that in the United States are done by officers, and thus we assign the pay of a first lieutenant to some of the enlisted men in these countries. In West Germany, for example, where officers make up 7.6 percent of military manpower, we take 6.6 percent of total manpower (14.2 percent minus 7.6 percent) from the career enlisted ranks and give it US first lieutenant pay. There are two exceptions to this approach. Canada has virtually the same proportion of officers as the United States; therefore, no adjustment for different personnel practices is made. Denmark is the only NATO country with a higher proportion of officers than the United States. As a result, as for the Warsaw Pact countries, we give some Danish officers the pay of US enlisted men. These officers are assumed to get a midlevel NCO grade of E-5, about $16,800.

Table B-1
Derivation of Dollar Pay Rates for NATO Conscripts [a]

	Conscript Average Length of Service (*months*) [b]	Weights for E-2 and E-3 To Give Equal Time in Service		Pay Rate (*1985 US $*)
		E-2	E-3	
Belgium [c]	5.0	1.000	0	10,148
Denmark	7.5	0.875	0.125	10,307
Germany	9.0	0.750	0.250	10,468
Greece	11.0	0.580	0.420	10,685
Italy [c]	6.0	1.000	0	10,148
Netherlands	7.5	0.875	0.125	10,307
Norway [c]	6.5	1.000	0	10,148
Portugal	9.5	0.700	0.300	10,532
Spain	7.5	0.875	0.125	10,307
Turkey	10.0	0.670	0.330	10,570
France [c]	6.0	1.000	0	10,148

[a] The United Kingdom, Canada, and Luxembourg have volunteer service.

[c] E-2 pay rate is assumed for conscripts in countries with average conscript time in service of five to seven months.

Figure 14
Comparison of Analog and UN PPPs

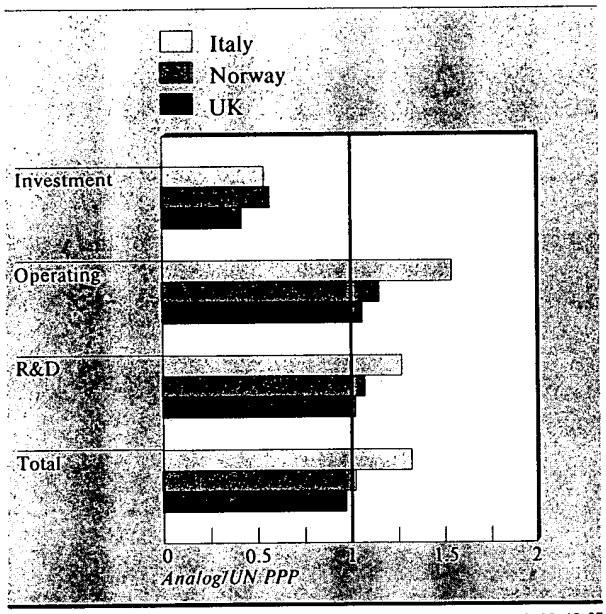
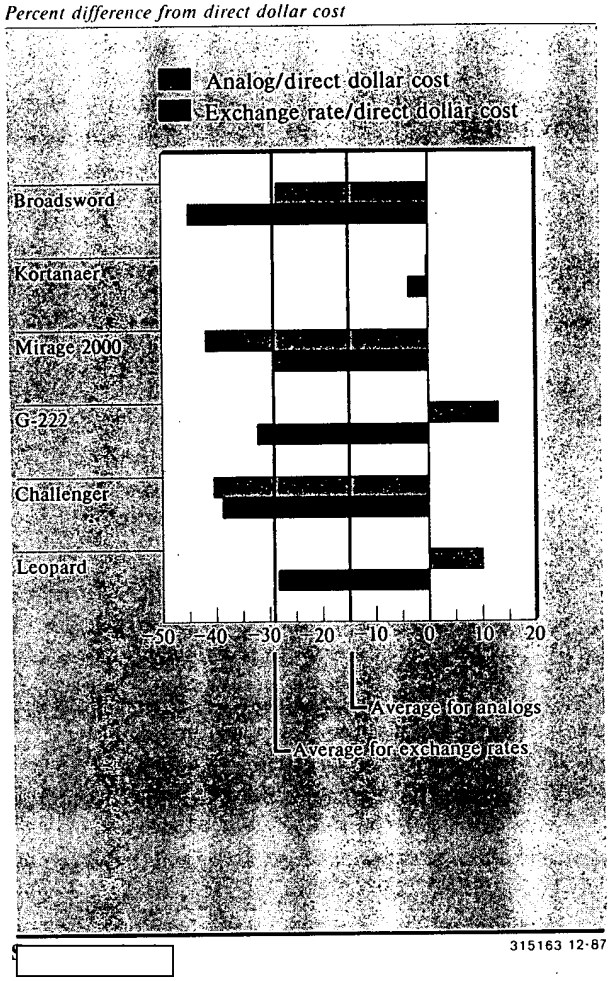


Figure 15
Comparison of Direct-Cost PPPs With Analogs and Exchange Rates



Civilian Pay

We multiplied the annual number of civilians reported in the DPQ for each country by the average per man cost of pay and benefits for civilians, both direct and indirect hires, working for the US Department of Defense.

Assessment of Results

We believe that our overall results are reasonable because they stood up well under two tests that we performed. First, we compared our work with that of the UN Group of Experts, which developed military PPPs for the United States and three other NATO countries for 1982.[18] Figure 14 shows the relationship between our analog PPPs and the Group's. Although we approached the problem differently, we ended up with similar findings for the totals. Where the Group believed its data to be best—operating and RDT&E costs—their results matched ours fairly well.[19] The UN's persistently low Italian PPP for these categories was traced to differences in the treatment of personnel. This discrepancy is not troubling because we

[18] UN General Assembly, *Reduction of Military Budgets: Construction of Military Price Indexes and Purchasing Power Parities for Military Expenditures*, A/40/421, 13 August 1985. (

[19] The UN PPP for Italian operating costs is lower than ours because the Group used different lira pay rates.

directly costed non-US NATO personnel costs. In fact, when the UN personnel parities are substituted for our directly costed personnel estimates, our overall Italian PPP matches that of the UN almost exactly. (

The UN's PPPs for investment were uniformly higher than our own. We decided to carry out a second test to assess the quality of our analog conversion factors because the UN admitted that its data were weak and uneven. For this purpose, we costed in dollars (using the same dollar-costing method used for the Warsaw Pact) six non-US NATO systems: two tanks (the British Challenger and the German Leopard II), two frigates (the British Broadsword and the Dutch Kortenaer), and two aircraft (the French Mirage 2000 and the Italian G-222). An implicit dollar cost PPP was derived by dividing the national currency price of these items by their dollar cost. We found that our analogs were reasonably close to these "actual cost" PPPs; the average difference was 14 percent, compared with an average error of 29 percent for exchange rates (see figure 15). We concluded, therefore, that the analog methodology yields more reasonable results than conversions using exchange rates.

Appendix C

Comparisons of the Characteristics and Costs of Selected US and Soviet Weapon Systems

This appendix presents comparisons of the characteristics and dollar costs of selected US and Soviet weapon systems, identifying the key features contributing to the differences or similarities between the estimated dollar costs of the Soviet systems and US weapons costs. The estimated dollar cost of the Soviet weapons discussed are derived by the building-block methods discussed in appendix A. The costs of US weapons were obtained from US Department of Defense *Selected Acquisition Reports* (SAR). We adjusted the SAR data to make them comparable in coverage to our estimates of the dollar value of the Soviet weapons. In the case of aircraft, for example, we adjusted the SAR cost to reflect only the fly-away cost plus initial spare parts and excluding any support equipment.

Readers should be aware that our confidence in estimates of the costs of an individual Soviet weapon system is lower than our confidence in cost estimates at a higher level of aggregation. The margin of error can be wider for some individual items than for the total because of a tendency of errors at low levels of aggregation to be partially offsetting.

Readers should also note that these comparisons do not by themselves indicate which weapon system is a "better buy," nor do they constitute a complete measure of weapon system capabilities. Such judgments would require a net technical assessment beyond the scope of this paper. We invite comments from our readership on how to improve these comparisons and how to make them more useful.

Table C-1
Tank Comparisons

	Soviet					US	
	T-64A	T-64B	T-72	T-72M1	T-80	M-1 Abrams	M-60A1
Weight (*tons*)	38	43	41	43	42-45	57	53
Engine							
Type	5-cylinder opposed diesel	5-cylinder opposed diesel	V-12 diesel	V-12 diesel	Turbine	Turbine	V-12 diesel
Horsepower	750	750	780	780	1,000	1,500	750
Transmission	Semi-automatic, 7 forward, 1 reverse	Semi-automatic, 7 forward, 1 reverse	Semi-automatic, 7 forward, 1 reverse	Semi-automatic, 7 forward, 1 reverse	Semi-automatic, with braking, 7 forward, 1 reverse	Automatic, 4 forward, 2 reverse	Automatic, 2 forward, 1 reverse
Suspension	Torsion bar	Torsion bar	Torsion bar	Torsion bar [a]	Torsion bar [b]	Torsion bar	Torsion bar
Main gun							
Bore type	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Rifled
Size	125 mm	125 mm	125 mm	125 mm	125 mm	120 mm	105 mm
ATGM	None	AT-8	None	None	AT-8	None	None
Fire-control rangefinder	Coincidence	Laser	Coincidence	Laser	Laster	Laser	Coincidence
Computer solution	Partial	Full	Partial	Full	Full	Full	Partial
Automatic loader	Yes	Yes	Yes	Yes	Yes	No	No
Night vision	Active infrared	Active infrared	Active infrared	Active infrared	Active infrared	Thermal imager	Active infrared
Electronic countermeasures	ECM against TOW, ATGM, laser-guided munitions	ECM against TOW, ATGM, laser-guided munitions	ECM against TOW, ATGM, laser-guided munitions	ECM against TOW, ATGM, laser-guided munitions	ECM against TOW, ATGM, laser-guided munitions	None	None
Estimated production	8,150	3,550	10,200	6,075	3,940	3,325	6,279
Cost (*average unit cost of first 1,000 units, CY 1985 dollars*)	$0.9 million	$1.2 million	$1.1 million	$1.1 million	$1.2 million	$1.6 million	$0.8 million

[a] May have variable height suspension.
[b] Probably has variable height suspension.

Principal differences: In addition to being heavier than the Soviet tanks and having a more powerful engine and an automatic rather than a semiautomatic transmission, the US M-1 tank is equipped with a costly thermal imager and a sophisticated gun stabilization system with an advanced fire-on-the-move capability that the Soviet tanks do not have. In comparison with the US M-60A1 tank, on the other hand, the Soviet tanks have more advanced fire-control systems, electro-optics, gun-missile systems, and laminated armor.

Table C-2
Infantry Fighting Vehicle Comparisons

	Soviet		US M-2 Bradley
	BMP-1	BMP-2	
Weight (*tons*)	13.8	13.8	26
Speed (*kilometers per hour*)	64	64	64
Range (*kilometers*)	590	590	500
Capacity (*troops*)	8	7	7
Crew	3	3	3
Engine			
Type	V-6 diesel	V-6 diesel	V-8 diesel
Horsepower	300	350	500
Armament	73-mm smooth-bore gun, 7.62-mm machine-gun	30-mm cannon, Spandrel and Spigot ATGMs (1 ready, 3 reserve), machine-gun	25-mm gun, TOW, machinegun
Estimated production	31,270	6,620	2,654
Cost (*average unit cost of first 1,000 units, CY 1985 dollars*)	$0.4 million	$0.5 million	$0.6 million

Principal differences: The US M-2 Bradley is heavier than comparable Soviet infantry fighting vehicles, has a more powerful engine, and is equipped with a thermal imaging sight and the TOW II ATGM.

Table C-3
Self-Propelled Artillery Comparison

	Soviet 2S3 152-mm SP Gun	US M109A 1/2 155-mm SP Gun
Weight (*tons*)	27	25
Speed (*kilometers per hour*)	62	56
Range (*kilometers*)	480	336
Range of gun (*meters*)	17,300	18,100
Rate of fire (*rounds per minute*)	3	8
Engine	V-12 diesel	V-8 turbo diesel
Crew	4	6
Estimated production	3,020	3,100
Cost (*average unit cost of first 1,000 units CY 1985 dollars*)	$0.6 million	$0.6 million

Principal similarities: The US M109A 1/2 and the Soviet 2S3 are similar in those characteristics that drive their respective costs, namely the hull, suspension, and turret. They are also similar in weight and in the range of their guns.

Table C-4
Bomber Comparison

	Soviet TU-160 Blackjack	US B-1B
Speed (*Mach*)	2	1.25
Maximum radius (*kilometers*)	10,200	6,800
Maximum weapon load (*kilograms*)	30,000	34,000
Takeoff weight (*kilograms*)	243,500	216,800
Length (*meters*)	53	45
Wingspan (*meters*)		
Spread	55	42
Swept	33	24
Armament	12 ALCMs, bombs, probable SRAM	24 SRAMs, 8 ALCMs, or up to 84 bombs [a]
Estimated production	8	28
Cost (*average unit cost of first 100 units, CY 1985 dollars*)	$125 million	$210 million

[a] External stores allow 14 additional ALCMs or SRAMs, or 48 bombs.

Principal differences: The US B-1B has a more advanced and redundant avionics suite than the Blackjack, and a higher performance and more fuel-efficient engine. The B-1B also embodies advanced technology design for drag reduction, reduced radar cross section, and forward canard control surfaces that enable low-altitude flight operation in turbulent air.

Table C-5
Transport Aircraft Comparison

	Soviet AN-124 Condor	US C-5B
Speed (*kilometers per hour*)	830	830
Range (*kilometers*)		
Maximum payload	3,480	5,243
Maximum fuel	13,760	10,350
Maximum weight (*kilograms*)	405,850	380,450
Maximum payload (*kilograms*)	150,315	98,180
Capacity		
Normal [a]	88 troops plus equipment	75 troops plus equipment
Alternate [b]	300-400 troops (low altitude only)	270 troops
Takeoff distance (*maximum load, meters*)	3,000	2,400
Landing distance (*maximum load, meters*)	800	750
Length (*meters*)	69	75
Cargo hold (*meters*)		
Length	43	44
Width	6.3	5.8
Height	4.2	4.2
Estimated production	9	29
Cost (*average unit cost of first 50 units, CY 1985 dollars*)	$130 million	$140 million

[a] Using upper cabin for troops.
[b] Using lower cabin for troops.

Principal differences: The entire C-5B cabin is pressurized, whereas the Condor is pressurized only in the upper cabin; the C-5B's landing gear has somewhat better flotation than the Condor's; the C-5B allows quicker loading and unloading operations; and it has greater redundancy in its electronic control systems.

Table C-6
Air Superiority Fighter Comparison

	Soviet SU-27 Flanker B	US F-15 Eagle
Maximum weight (*kilograms*)	25,470	25,450
Payload (*kilograms*)	1,320	1,315
Length (*meters*)	21.6	19.4
Wingspan (*meters*)	14.6	13.0
Range (*kilometers*)		
Ferry	3,710	4,800
Combat	1,260	1,530
Speed (*Mach*)	2.3	2.5
Armaments	6 AAMs, cannon	8 AAMs, Cannon
Estimated production	184	882
Cost (*average unit cost of first 250 units, CY 1985 dollars*)	$15 million	$22 million

Principal differences: The US F-15 has greater range and can fly at greater speed than the Soviet SU-27 Flanker B. It also has a better engine, more advanced avionics, and an airframe designed to last longer and operate under more stressful conditions.

Table C-7
Counterair Fighter Comparison

	Soviet MIG-29 Fulcrum	US F/A-18 Hornet
Weight (*kilograms*)	17,900	23,540
Payload (*kilograms*)	3,500	7,710
Length (*meters*)	16.0	17.1
Wingspan (*meters*)	11.4	11.4
Range (*kilometers*)		
Ferry	2,270	3,700
Combat	720	740/1,065 [a]
Speed (*Mach*)	2.2	1.8
Armament	6 AAMs	4 AAMs
Estimated production	397	332
Cost (*average unit cost of first 250 units, CY 1985 dollars*)	$12 million	$25 million

[a] 740 kilometers in the air-to-air mission; 1,065 kilometers in the ground attack mission.

Principal differences: The F/A-18, unlike the MIG-29, is designed for aircraft carrier operations. This requires special features for catapult-assisted takeoff, for landing with use of arresting devices, and for maintenance onboard ship; folding wings for space conservation; and corrosion resistance for operations at sea. In addition, the F/A-18 was designed to have capabilities in the ground attack and air superiority roles, whereas the MIG-29 was designed primarily for the counterair mission, with ground attack as a secondary role.

Table C-8
Attack Helicopter Comparison

	Soviet MI-24 Hind	US Cobra AH-1S
Capacity	3 crewmen, 8 troops	2 crewmen
Weight empty (*kilograms*)	7,570	3,000
Length (*meters*)	21.5	16
Speed (*kilometers*)	304	226
Range (*kilometers*)	432	500
Ceiling (*meters*)	3,880	3,700
Armament	ATGM, gun	TOW, gun, rockets
Estimated production	1,695	1,075
Cost (*average unit cost of first 250 units, CY 1985 dollars*)	$5.1 million	$3.7 million

Principal differences: The Soviet MI-24 Hind helicopter is larger, heavier, and faster than the US Cobra. The Hind is larger because it was originally designed to ferry troops into combat; it is faster than the Cobra because it has two engines compared to one on the Cobra. The Cobra, on the other hand, has relatively advanced avionics.

Table C-9
Nuclear-Powered Attack Submarine Comparison

Class	Soviet		US
	Akula	V-III	Los Angeles
Beam (*meters*)	11.1	10.0	10.0
Length (*meters*)	106.4	103.3	109.1
Submerged displacement (*tons*)	8,300	6,300	6,900
Speed (*knots*)	30	30	30
Maximum depth (*meters*)	Unknown	394	447
Armament	6 tubes, 18 torpedoes	6 tubes, 18 torpedoes	4 tubes, 8 Tomahawks, 4 Harpoons
Estimated production	2	21	36
Cost (*average unit cost of first 10 units, CY 1985 dollars*)	$370 million	$320 million	$270 million

Principal differences: The Soviet Akula-class submarine is heavier than the US Los Angeles–class SSN in displacement and larger in diameter, probably has a double hull, and has twin reactors and greater power.

The Soviet V-III SSN is shorter and lighter than the Los Angeles, has double-hull construction, and two nuclear reactors.

Table C-10
Nuclear-Powered Aircraft Carrier Comparisons

	Soviet	US
Class	Leonid Brezhnev	Nimitz
Beam (*meters*)	38	41
Length (*meters*)	298	331
Flight deck width (*meters*)	73	76-78
Full-load displacement (*tons*)	64,000-75,000	91,500
Speed (*knots*)	32	30-35
Armament	50+ short take-off and landing aircraft, probable defensive missiles (SAMs), conventional takeoff and landing aircraft using ski jump at bow, 2 lifts	4 steam catapults, 90+ conventional takeoff and landing aircraft, 3-point defense missile system, 4 lifts
Estimated production	2 [a]	5
Cost (*average unit cost of first 10 units, CY 1985 dollars*)	$1.4 billion	$3.3 billion

[a] Both units are under construction. The first is expected to be completed in 1989, and the second in 1992.

Principal differences: The Soviet Brezhnev-class aircraft carrier is smaller than the US Nimitz class. In addition, the Brezhnev class is at present incapable of operating CTOL aircraft and can carry only about half as many aircraft as the Nimitz.

Table C-11
Guided Missile Cruiser Comparison

	Soviet	US
Class	Slava	Ticonderoga
Beam (*meters*)	20	17
Length (*meters*)	186	172
Full-load displacement (*tons*)	12,500	9,600
Speed (*knots*)	34	30
Armament	2 130-mm guns	2 5-inch guns
Guns	6 30-mm Gatling guns	2 20-mm Phalanx defense systems
Missiles		
SSM	16 SS-N-12 2 SS-N-4 twin launchers, 40 missiles	8 Harpoon quad launchers
SAM/ASW	8 SA-N-6 launchers (64 missiles), 2 rocket-propelled depth charges	88 Standard /ASROC, 2 twin launchers
Helicopters	1 Hormone	2 Lamps
Torpedoes	8 in hull	6 MK-32s in 2 triple launchers
Estimated production	2	4
Cost (*average unit cost of first 10 units, CY 1985 dollars*)	$0.4 billion	$1.1 billion

Principal differences: The US Ticondercga-class CG carries the AEGIS weapons control system, has numerous redundant electronic systems, and incorporates features designed to provide better living conditions for the crew.

Appendix D

Statistical Tables

Table D-1
Dollar Value of Warsaw Pact and NATO Defense Activities by Resource Category, 1976-86 [a]

Billion 1985 US $

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	Cumulative
Warsaw Pact total	**263**	**265**	**269**	**274**	**279**	**280**	**281**	**286**	**289**	**293**	**297**	**3,075**
Investment	82	82	82	85	85	83	82	83	83	84	84	914
Procurement	70	70	70	72	72	71	69	70	70	72	72	778
Construction	12	12	12	12	13	12	13	13	13	13	12	137
Operating	153	154	156	158	161	163	165	167	168	169	171	1,785
Personnel	92	93	94	95	97	97	98	98	99	98	99	1,059
O&M	61	62	62	64	64	66	67	68	69	71	73	726
RDT&E	28	28	30	31	33	34	35	37	38	40	42	375
NATO total	**276**	**282**	**287**	**294**	**302**	**313**	**330**	**349**	**361**	**373**	**378**	**3,544**
Investment	49	51	54	62	65	72	81	92	100	106	109	842
Procurement	41	44	47	55	58	65	73	83	91	97	100	753
Construction	8	8	7	7	7	7	8	9	9	9	9	89
Operating	202	205	207	205	209	213	220	225	226	229	230	2,370
Personnel	98	98	96	96	97	98	100	102	102	103	105	1,094
O&M	104	107	111	110	112	115	120	123	123	126	125	1,276
RDT&E	25	26	26	27	27	28	29	32	35	38	39	332

[a] Because of rounding, data may not add to totals shown.

Table D-2
Dollar Value of Soviet and US Defense Activities by Resource Category, 1976-86 [a]

Billion 1985 US $

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	Cumulative
Soviet total	**218**	**220**	**224**	**228**	**233**	**233**	**236**	**240**	**244**	**247**	**253**	**2,576**
Investment	72	72	73	74	75	72	72	73	73	74	75	805
Procurement	62	62	62	64	64	62	62	62	62	64	65	690
Construction	10	10	10	10	11	10	11	11	11	11	10	115
Operating	120	121	123	124	127	129	131	132	134	135	137	1,412
Personnel	73	73	74	75	77	77	78	78	78	78	78	840
O&M	47	48	49	50	50	52	53	54	55	56	59	572
RDT&E	26	27	29	29	32	32	33	35	37	38	40	358
US total	**157**	**160**	**162**	**168**	**174**	**183**	**200**	**217**	**230**	**244**	**250**	**2,143**
Investment	32	34	36	41	44	49	58	68	75	82	85	605
Procurement	29	31	33	39	41	46	54	64	71	77	80	564
Construction	4	4	3	3	3	3	4	4	4	5	5	41
Operating	106	106	106	107	110	113	119	124	126	130	132	1,279
Personnel	47	46	45	45	46	46	48	49	50	52	53	528
O&M	59	60	61	62	64	66	71	74	76	79	80	751
RDT&E	19	19	19	19	20	21	23	26	29	31	32	259

[a] Because of rounding, data may not add to totals shown.

Table D-3
Dollar Value of Non-Soviet Warsaw Pact and Non-US NATO Defense Activities by Resource Category, 1976-86 [a]

Billion 1985 US $

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	Cumulative
NSWP total	**45**	**45**	**45**	**46**	**46**	**46**	**45**	**46**	**46**	**46**	**45**	**499**
Investment	10	10	10	11	10	11	10	10	10	10	9	109
Procurement	8	8	8	9	8	9	8	8	8	8	7	88
Construction	2	2	2	2	2	2	2	2	2	2	2	22
Operating	33	33	33	34	34	34	34	34	34	34	34	373
Personnel	20	20	20	20	20	20	20	20	20	20	20	219
O&M	14	14	14	14	14	14	14	14	14	14	14	154
RDT&E	2	2	2	2	2	2	1	1	1	1	1	17
Non-US NATO total	**119**	**122**	**125**	**126**	**128**	**130**	**130**	**132**	**131**	**130**	**129**	**1,401**
Investment	16	17	18	20	21	24	24	24	25	25	24	237
Procurement	12	13	14	16	17	19	19	19	20	20	20	189
Construction	4	4	4	4	4	4	5	5	5	5	4	48
Operating	96	99	100	99	99	100	101	101	100	99	98	1,091
Personnel	51	52	51	51	51	52	52	52	52	52	52	566
O&M	45	47	50	48	48	48	49	49	48	47	46	525
RDT&E	6	6	7	7	7	7	6	7	7	7	7	73

[a] Because of rounding, data may not add to totals shown.